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# PROCEEDINGS

OF THE

GENERAL MEETINGS FOR SCIENTIFIC BUSINESS

OF THE

ZOOLOGICAL SOCIETY

OF LONDON.

1902, vol. I.

(JANUARY—APRIL.)

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PRINTED FOR THE SOCIETY,  
AND SOLD AT THEIR HOUSE IN HANOVER-SQUARE.

LONDON:

MESSRS. LONGMANS, GREEN, AND CO.,  
PATERNOSTER ROW.

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1902.

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January 14, 1902.

Prof. G. B. HOWES, LL.D., F.R.S., Vice-President,  
in the Chair.

The Secretary read the following report on the additions to the Society's Menagerie during the month of December 1901 :—

The registered additions to the Society's Menagerie during the month of December 1901 were 51 in number. Of these 11 were acquired by presentation and 4 by purchase, 6 were born in the Gardens, and 30 were received on deposit. The total number of departures during the same period, by death and removals, was 146.

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Dr. A. S. Woodward, F.R.S., exhibited a newly-discovered upper molar tooth of a Fossil Horse, *Onohippidium*, from the cavern near Consuelo, in Last Hope Inlet, Patagonia<sup>1</sup>. This specimen was fixed in the bone and carried traces of the soft parts.

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Mr. Oldfield Thomas, F.R.S., exhibited the skin and skull of a female Yellow-backed Duiker (*Cephalophus sylvicultrix*) which

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<sup>1</sup> Cf. P. Z. S. 1900, p. 76.

had been obtained by Mr. B. B. Johnstone (Native Commissioner) in the Awemba district of North-eastern Rhodesia, and had been sent home and presented to the British Museum by Mr. Robert Codrington, Administrator of that country.

This specimen proved a very considerable extension of the range of the species, hitherto known only from West Africa, where it had a wide distribution, from Sierra Leone to Angola. No differences of importance, however, were perceptible between the Rhodesian specimen and examples from West Africa.

Since Mr. Codrington's specimen had arrived, a frontlet and piece of skin of the same species had also been received from Mr. O. Baragwanath of Bulawayo, and this, it was believed, had been obtained in the same district.

In N.E. Rhodesia this Antelope was said by Mr. B. B. Johnstone (who had obtained the specimen for Mr. Codrington) to be met with in stony localities at fairly high altitudes. It was supposed to occur throughout the Luemba Highlands and along the Mohinga Mountains east of Lake Bangweolo, but was not common. Its cry was like that of a Duiker. Its native name was "Chibusimawe" (=Big Mountain Goat).

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Mr. W. B. Tegetmeier, F.Z.S., exhibited the skin of an animal which it had been suggested was a hybrid between a Hare and a Rabbit, but which had proved to be merely a Mountain Hare (*Lepus variabilis*).

Mr. Tegetmeier also exhibited a skull of a Rabbit showing overgrown incisors in both jaws.

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The following papers were read :—

1. On Variation in the Number and Arrangement of the Male Genital Apertures in the Norway Lobster (*Nephrops norvegicus*). By F. H. A. MARSHALL, B.A., Christ's College, Cambridge<sup>1</sup>.

[Received November 21, 1901.]

(Text-figures 1-3.)

The total number of specimens of the Norway Lobster examined for the purposes of this investigation was 1123, of which 1080 were males. The latter presented no less than ten different arrangements of the genital apertures, in addition to the normal arrangement of an opening on the basal joint of each of the fifth walking-legs. Before giving the numerical details of the degrees

<sup>1</sup> Communicated by W. BATESON, F.Z.S.

of frequency of these arrangements, it will be convenient to describe each of them separately. They are as follows :—

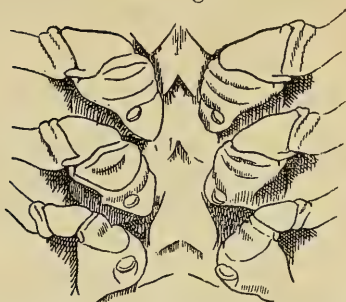
- A. The normal arrangement.
- B. The normal apertures and two additional ones at the bases of the fourth legs, making a total of four apertures.
- C. The normal apertures and an additional one at the base of the left fourth leg, making a total of three apertures.
- D. The normal apertures and an additional one at the base of the right fourth leg, making a total of three apertures.
- E. The normal apertures and four additional ones on the third and fourth legs, making a total of six apertures.
- F. The normal apertures and three additional ones on the fourth legs and the left third leg, making a total of five apertures.
- G. The normal apertures and three additional ones on the fourth legs and the right third leg, making a total of five apertures.
- H. The normal apertures and two additional ones on the left third and left fourth legs, making a total of four apertures.
- K. The normal apertures and an additional one on the left third leg (there being a gap in the series), the total number of apertures being three.
- L. The normal apertures and two additional ones on the right third and left fourth legs, the total number of apertures being four.
- M. The normal apertures and five additional ones on the fourth and third legs and also on the left second leg, the total number of apertures being seven.

These arrangements may be represented graphically as follows :—

B.		C.			D.		E.	
<i>r.</i>	<i>l.</i>	<i>r.</i>	<i>l.</i>		<i>r.</i>	<i>l.</i>	<i>r.</i>	<i>l.</i>
				Third legs.			.	.
.	.	.	.	Fourth legs.	.		.	.
.	.	.	.	Fifth legs.	.	.	.	.
F.		G.			H.		K.	
<i>r.</i>	<i>l.</i>	<i>r.</i>	<i>l.</i>		<i>r.</i>	<i>l.</i>	<i>r.</i>	<i>l.</i>
	.	.		Third legs.		.		.
.	.	.	.	Fourth legs.		.		.
.	.	.	.	Fifth legs.	.	.	.	.
		L.			M.			
		<i>r.</i>	<i>l.</i>		<i>r.</i>	<i>l.</i>		
				Second legs.		.		
		.		Third legs.	.	.		
		.	.	Fourth legs.	.	.		
		.	.	Fifth legs.	.	.		

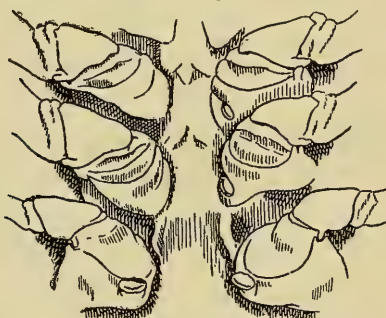
[The letters  $r$ . and  $l$ . denote the right and left sides.]

Text-fig. 1.

Genital apertures of *Nephrops norvegicus*.

Male of *Nephrops norvegicus* having abnormal genital apertures on each of the third and fourth walking-legs.

Text-fig. 2.

Genital apertures of *Nephrops norvegicus*.

Male of *Nephrops norvegicus* having abnormal genital apertures on the right third and right fourth walking-legs.

In no specimen was either of the normal apertures wanting.

The animals were examined in batches—the first batch, which was much the largest, consisting of the stock of Norway lobsters in the zoological laboratory of the University of Edinburgh, obtained for the use of students during the summer session. The rest were procured at various intervals of time during the summer and autumn. The numerical details of these batches are now given:—

(1) Females .....	56			
Normal males.....	485			
Abnormal males with arrangement B...	23	} 63	} 548	
Ditto with arrangement C .....	21			
"          "          D .....	17			
"          "          E .....	1			
"          "          H .....	1			
Total ...		604		



(2) Females .....	2			
Normal males.....	60			
Abnormal males with arrangement B...	3	7	}	67
Ditto with arrangement C .....	1			
" " D .....	2			
" " K .....	1			
Total ...	69			

(3) Females .....	3			
Normal males.....	80			
Abnormal males with arrangement B...	5	14	}	94
Ditto with arrangement C .....	3			
" " D .....	3			
" " F .....	2			
" " M .....	1			
Total ...	97			

(4) Females .....	4			
Normal males.....	95			
Abnormal males with arrangement B...	1	13	}	108
Ditto with arrangement C .....	8			
" " D .....	2			
" " F .....	1			
" " G .....	1			
Total ...	112			

(5) Females .....	1			
Normal males.....	41			
Abnormal males with arrangement B...	2	8	}	49
Ditto with arrangement C .....	1			
" " D .....	2			
" " E .....	1			
" " G .....	1			
" " L .....	1			
Total ...	50			

(6) Females .....	1			
Normal males.....	22			
Abnormal males with arrangement B...	1	2	}	24
Ditto with arrangement D .....	1			
Total ...	25			

(7)	Females .....	1			
	Normal males.....	73			
	Abnormal males with arrangement B...	4	} 12	} 85	
	Ditto with arrangement C .....	5			
	"              "          D .....	3			
		<hr/>			
	Total ...	86			
		<hr/>			
(8)	Normal males.....	22			
	Abnormal males with arrangement B...	1	} 3	} 25	
	Ditto with arrangement C .....	1			
	"              "          D .....	1			
		<hr/>			
	Total ...	25			
		<hr/>			

Adding all these together we arrive at the following result :—

Females .....	68	} 122	} 1000
Normal males .....	878		
Abnormal males with arrangement B...	40		
Ditto with arrangement C .....	40		
"              D .....	31		
"              E .....	2		
"              F .....	3		
"              G .....	2		
"              H .....	1		
"              K .....	1		
"              L .....	1		
"              M .....	1		
Grand Total ...	1068		

The total number of male Norway lobsters examined being 1000<sup>1</sup>, the percentage of abnormality occurring among them is shown to be 12·2. The numerical variation in the apertures, but not the variation in their arrangement, I have indicated by a percentage curve (text-fig. 3, p. 7). It is of interest to note that the homœosis occurs with little regard to bilateral symmetry.

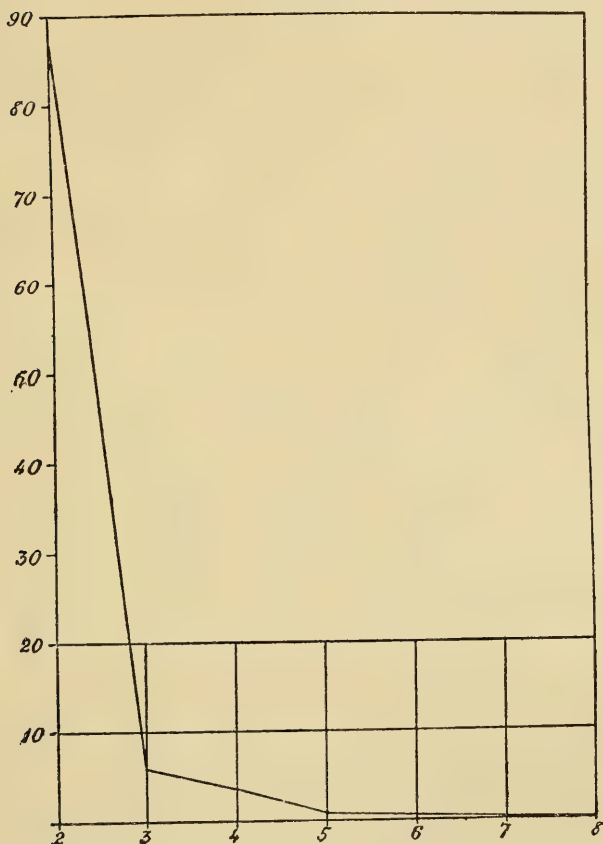
The relative scarcity of females is worthy of comment. It may be that the majority of them had migrated to a greater distance from land. The 68 specimens that were examined possessed only the normal apertures on the third pair of walking-legs. Dr. Malcolm Laurie, however, tells me of a female specimen in his possession which has two pairs, the additional ones being on the fourth pair of legs.

The 1068 Norway lobsters which enter into my calculations

<sup>1</sup> Since the above was written I have received 24 male Norway lobsters from the Forth area, 21 being normal, one showing arrangement C and another arrangement D, while a third presented an arrangement not hitherto observed, having apertures upon the left third and right fourth walking-legs in addition to the normal ones, the total number of apertures being four.

were all obtained from the area of the Firth of Forth. In addition to these I procured 80 specimens which were caught off the Isle of Man. Of these two were females, one was an abnormal male having two pairs of genital apertures, and the rest were

Text-fig 3.

Diagram illustrating variation in genital apertures in *Nephrops norvegicus*.

Percentage-curve illustrating variation in the number of genital apertures in 1000 male specimens of *Nephrops norvegicus*. The lower figures give the number of apertures and the side figures the percentage of individuals.

normal males. The number is, of course, not large enough for any definite conclusions to be based upon it; but in view of the fact that I never obtained even smaller batches from the Forth area without finding a much higher percentage of abnormality, the presence of only a single abnormal specimen among the Isle

of Man lobsters may point to the percentage being related to the locality<sup>1</sup>.

The positions of the additional openings upon their respective legs are approximately the same as those of the normal ones on the fifth legs. In the case of those specimens with three pairs of openings, the most anterior of which are situated on the third legs in the position of oviducal openings, it is clear, if only from the modification of the anterior abdominal appendages, that the specimens are males. The abnormal apertures are sometimes smaller than the normal ones, though they may be even larger. In the case of the single specimen showing seven spermatid apertures, the six posterior openings are of about equal size, while the opening on the second thoracic leg on the left side is very much smaller but still quite obvious.

The state of preservation of the majority of the specimens rendered it impossible to determine the structure of the internal genital organs. In the fresh specimens it could, however, in some cases be made out that the apertures opened internally into blind sacs. In a few there appeared to be duct-like extensions of these sacs internally. In a fair proportion the vasa deferentia gave off branches which extended for a short distance towards the abnormal openings. In at least one instance these anterior forks of the vasa deferentia reached the bases of the legs on which the abnormal apertures were situated. Whether there is ever a free functional passage from the position of the forking to the abnormal aperture it is difficult to say with certainty.

That Norway lobsters with additional genital apertures have been common in Scottish waters for a considerable number of years, appears from information supplied me by Professor Ewart, Dr. Beard, Dr. Masterman, and others. Before I began my investigation on the degree of frequency of such abnormal lobsters, Dr. Masterman expressed the opinion that quite 10 per cent. of the specimens he had observed since he had been in Scotland had additional genital openings; and Dr. Beard, who has had occasion to examine a very large number, speaks to me of regular epidemics of this kind of abnormality in some years in the past, the students in the laboratory experiencing great difficulty in distinguishing the males from the females.

The only published record, so far as I know, of additional genital openings in *Nephrops* is a recent paper by Mr. Cole, who states that "abnormalities in oviducal and spermatid apertures are by no means uncommon, and I remember examining three specimens, two of which were abnormal and had four supernumerary spermatid apertures occurring as follows:—

	Third walking-legs.	•
•	Fourth walking-legs.	•
•	Fifth walking-legs.	•
		•

<sup>1</sup> Mr. Bateson informs me that he has noticed some variation in the degree of frequency of abnormality in regard to the oviducal apertures in batches of *Astacus* procured at various times for the Zoological Laboratory at Cambridge, and is of opinion that this variation is probably related to the localities from which the batches were obtained.



Mr. Bateson has, however, placed on record several cases of females of *Astacus fluviatilis* with additional oviducal apertures, but their degree of frequency was not nearly so great as that of the abnormal spermatid apertures in *Nephrops*. After citing Desmarest's observation of a female *Astacus* with oviducal apertures on both the antepenultimate and penultimate legs, to each of which the oviducts branched, he describes several cases that he has himself observed. Among 583 female *Astaci* he records 23 which were abnormal in regard to the genital apertures, 17 having an opening on one of the fourth legs, one with an opening on each of the fourth legs, one with one opening on each of the fourth and fifth legs (in each case in addition to the normal openings), and four in which one of the normal openings was wanting. The oviducts in most cases gave off branches to the abnormal openings as in Desmarest's specimen. Mr. Bateson cites Dr. Benham's observation on a female crayfish which had a pair of supernumerary openings on the fifth legs but none on the fourth. Out of 714 males that Mr. Bateson examined, one was abnormal in having no spermatid aperture on the right side. No cases of additional spermatid apertures are recorded for *Astacus*.

The above-described variations in *Nephrops* would appear to have some bearing on the supposed cases of hermaphroditism among the Astacidae. La Valette St. George has described a specimen of *Astacus fluviatilis*, in its external characters a male, but with what appeared to be a hermaphrodite gland. Bergendal in two papers has recorded his observations on females of *Astacus fluviatilis* in which the appendages of the first abdominal somite were modified as in the male; and Faxon has cited other cases of partial or complete hermaphroditism. But it is only those cases where the evidence of hermaphroditism is supplied by the existence of apertures situated as in one sex, in animals which in many characters resemble the other sex, which specially concern the subject of this paper.

In his 'Revision of the Astacidae' Faxon gives an account of a specimen of *Cambarus propinquus*, which appears to have been an undoubted female, for ovarian eggs were found on dissecting it. The external characters, including the condition of the appendages of the first and second abdominal somites, were also those of the female, with the exception of the position of the genital apertures, which were on the last pair of thoracic legs—i. e., in the position typical of the male.

Lönnberg states that he believes he has seen rudimentary genital ducts passing to the third pair of thoracic legs in two specimens of *Cambarus fallax*, but owing to their state of preservation he is not positive.

Von Martens has long ago recorded the presence of additional apertures on the bases of the antepenultimate legs in certain male specimens of *Cheraps preissii*, *Astacus pilimanus*, and *A. brasiliensis*, the two latter of which are now included in Huxley's genus *Parastacus*.

Von Ihering describes these apertures which occur in all the

specimens of *Parastacus* he saw as follows:—"Il y a sur le coxopodite de la troisième jambe, une ouverture ovale qui est fermée par un écusson bombé et que l'on peut déprimer du côté médian ou libre." The state of preservation was not good, but von Ihéring says:—"Il m'a paru qu'un conduit très délicat se dirigeait plus en avant, à l'ouverture du troisième coxopodite, mais je ne puis l'affirmer." Whether or not the specimens dissected were hermaphrodite, von Ihéring is apparently also doubtful.

Faxon records the coexistence of both pairs of apertures in all the specimens he has examined of *Parastacus saffordi*, *P. varicosus*, *P. defossis*, and *P. hassleri*, but not in specimens of *P. agassizii*. No account of the internal genital organs is given by Faxon.

The best and most recent account of the supernumerary apertures and ducts of *Parastacus* is by Lönnberg, who describes both sexes, which differ not only in their internal but also in their external characters. The species described is *P. hassleri*. Not only do the males have supernumerary apertures and ducts in the 11th somite, but the females also in the 13th somite, in the position of the normal apertures of male crayfish. Although the supernumerary ducts have a lumen they are not functional, since the additional genital orifices in the male are only shallow grooves and those in the female are closed by a membrane. The additional openings in the male are closely similar in appearance to the functional openings of the female. Lönnberg states that he has found bodies resembling eggs in the testis, but he thinks it improbable that they "can be fully developed, still less of propagative use." He draws the conclusion that "in *Parastacus hassleri* a partial hermaphroditism is prevailing." It is interesting to note that the apertures in most species of *Parastacus*<sup>1</sup> are on the same somites as in the abnormal *Astacus* described by Benham.

In view of the frequent occurrence of genital apertures in *Nephrops* on the basal joints of other legs than the third and fifth, the coexistence of apertures upon these legs cannot be regarded as conclusive evidence of a partially hermaphrodite condition as some authors have supposed. Apertures on the fourth pair of legs have not, so far as I know, been recorded for *Parastacus*, but it is not unreasonable to suppose that if a large number of specimens were examined they would be found to occasionally occur.

To those who will regard the abnormal genital openings in *Nephrops* as evidence that the apertures and ducts were metamerically repeated in past times, all the above-cited cases must be interesting in view of Lankester's suggestion that the genital ducts of Arthropods are derived from nephridia. Allen has described the genital ducts in young adults of *Palæmonetes* as

<sup>1</sup> Mr. Borradaile has called my attention to the fact that in male specimens of *Pagurus deformis* M.-Edw. the female apertures also normally occur. *Vide* Borradaile, "On some Crustaceans from the South Pacific, Part II," P. Z. S. 1898, where references are given.

agreeing "in all their relations with those of *Peripatus*," and the probability of their being derived from nephridia he regards as "very great." It is, however, very doubtful whether the case of *Nephrops* has any real bearing on this question, seeing that in *Astacus* we may also get variation in the direction of reduction of apertures, and in *Cambarus* simple homœotic shifting of the apertures without any addition to their number.

However this may be, the occurrence of such a high percentage of a particular kind of abnormality as I have recorded among the Norway lobsters of the Forth area during the present year is instructive as supplying another example of the falsity of the doctrine that a well-marked variation cannot exist with any considerable degree of frequency owing to the so-called "swamping effects of intercrossing."

Specimens illustrating the various arrangements of the genital apertures described in this paper were exhibited before the Zoological Section of the Meeting of the British Association at Glasgow.

In conclusion I must express my indebtedness to Mr. Bateson, by whom I was induced to undertake this investigation.

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## 2. On some remarkable Digestive Adaptations in Diprotodont Marsupials. By Dr. EINAR LÖNNBERG, C.M.Z.S.

[Received November 18, 1901.]

(Text-figures 4–6.)

While dissecting for other purposes some Phalangerids, my attention was attracted by the great difference in the development of the intestine in the different species. As some of the observations made at the time are of a certain interest, the following account of the comparison of the conditions found in the different animals may perhaps be acceptable.

Before I proceed to report upon my own investigations, some preliminary remarks may be made concerning the views of other authors in similar cases.

The correspondence between an animal’s diet and the development of the different parts of its intestine is a well-known fact; but, on the other hand, the reason why this must be so has been comparatively little discussed. Ellenberger, for instance, has stated that the great development of the cæcum in the Horse stands in connection with its diet, which chiefly consists of matter rich in cellulose. The food passes in this animal rather rapidly through the stomach and the small intestine, but is then retained in the cæcum, where, to a great extent, digestion and absorption take place. In his papers on Rodents, especially in his great work ‘Ueber das System der Nagetiere,’ Tullberg has expressed the opinion that digestion and absorption of cellulose take place in the cæcum and the colon. He says also that the digestion of this kind of food is not only dependent on the length and width of these intestinal tracts, but also on the slowness with which the food passes through these parts of the intestine. There are in fact to be found many structural adaptations for the purpose of retaining the food or retarding its passage. The same author also discusses the reason why some animals among the Rodents, viz. the Myoxids, have lost their cæcum. He believes that such a reduction is the result of a diet chiefly consisting of such



substances (amylum, fat, proteine), the digestion of which may take place in the small intestine without the help of any cæcum and without any specialization of the colon. Vegetable food may thus, just as well as a carnivorous diet, lead to the loss of the cæcum. He also draws attention to the condition found in the peculiar Phalangerid *Tarsipes*, in which the cæcum is entirely wanting, and thinks that this depends upon the fact that this animal feeds chiefly on honey. This last statement is of special interest because *Tarsipes* belongs to the same family as the animals which are to be considered here; and it might, with regard to the development of its intestine, be put at one end of the series described below.

The chief material for this little study was afforded by some specimens of *Phalanger maculatus* and *Petaurus breviceps*, collected in New Guinea by the late Dr. E. Nyman; a specimen of *Pseudochirus occidentalis* brought home from Western Australia by the late Captain Forsström; and a specimen of *Trichosurus vulpecula* from an unknown locality. In addition to these I have, with the kind permission of my friend Professor T. Tullberg, had the opportunity of using other available material in the Zoological Museum of the Royal University at Upsala, and I beg to offer him my best thanks for these new proofs of his never-ceasing liberality.

My first attempt was to try to find out on what kind of diet the above-mentioned animals lived, by carefully examining the contents of the stomach and the intestine. The stomach of the *Petaurus* contained pieces of the chitinous integument of various insects and larvæ, some whole Podurids, and hair of the animal itself. Among the Podurids my friend E. Wahlgren was able to distinguish specimens of *Isotoma palustris* and of an *Achorutes*. It seems accordingly to be certain that this animal may be termed entomophagous, although perhaps also berries etc. may enter into its diet. The stomach and the intestine of the *Phalanger maculatus* were completely filled with fruit-pulp, and there is thus reason to regard this Cuscus as chiefly carpophagous. The stomach in my specimens of *Pseudochirus* and *Trichosurus* was empty; the contents of the intestine and especially the cæcum indicated, however, a vegetable origin. In the cæcum of *Trichosurus* comparatively large pieces of the fibrous skeleton of leaves could be found, but the parenchymatous substance was digested or, at any rate, loosened from the "nerves." This agrees well with Lydekker's words—"the highly aromatic leaves of the Peppermint-gum form the favourite food of these animals."<sup>1</sup> The cæcum of *Pseudochirus* was filled with a substance in which, under the microscope, various parts of leaves, upper and lower epiderm, bundles of vessels, etc. could be discerned. There was also a good deal of fine sand, which, probably as dust, had once covered the leaves and sprouts on which the *Pseudochirus* had

<sup>1</sup> Lydekker: 'A Handbook to the Marsupialia and Monotremata.' London, 1894.



fed, and thus been swallowed together with the vegetable matter. *Trichosurus* and *Pseudochirus* are thus chiefly phyllophagous, and so also is the Koala (*Phascolarctos*), which feeds on Eucalyptus-leaves. Of the latter I have had only scant material—the dried cæcum of a grown animal and the intestine of a fœtus. It may, however, also be considered in this comparison because its anatomy is known from the descriptions of Owen<sup>1</sup> and Forbes<sup>2</sup>.

For the purpose of illustrating the length of the different parts of the intestine, the measurements are given in the following table<sup>3</sup>:—

	<i>Trichosurus.</i>	<i>Pseudochirus.</i>	<i>Phalanger.</i>	<i>Petaurus.</i>
Length of animal without tail ...	39 cm.	28.5 cm.	58 cm.	14 cm.
Small intestine...	213 „	139.5 „	198 „	48 „
Cæcum .....	23 „	42.5 „	69 „	5.5 „
Large intestine...	122 „	87.2 „	261 „	11 „

To make the comparison easier it is, however, convenient to express the relation between the length of the different parts of the intestine and the length of the animal itself (without tail). This is done in the following table, in which the numbers indicate percentages of the length of the animal without tail. The numbers under the head of *Phascolarctos* are calculated from the measurements of this animal recorded by Forbes (*l. c.* p. 184). There are also added measurements taken by myself from a specimen of the small insectivorous *Acrobates pygmaeus*.

In percentage of the animal's length without tail.	<i>Phascolarctos.</i>	<i>Trichosurus.</i>	<i>Pseudochirus.</i>	<i>Phalanger.</i>	<i>Petaurus.</i>	<i>Acrobates.</i>
Small intestine...	542	546	496	360	342	250
Cæcum .....	321	59	149	125	39	22.8
Large intestine...	784	312	305	474	78	(mutilated)

A glance at this table reveals that in the Koala all parts of the intestine are very much more lengthened than the corresponding parts of the intestine of the animals at the other end of the series. The cæcum and the large intestine are considerably larger even than in the likewise chiefly phyllophagous *Trichosurus* and *Pseudochirus*. On the other hand, all three phyllophagous animals have the small intestine developed in comparatively the same degree but a good deal longer than in the others. The reason why the cæcum and the large intestine in *Trichosurus* and *Pseudochirus* are comparatively shorter than the same organs in the Koala may be seen from the description further on. If the digestion of the cellulose takes place chiefly in the cæcum, as has been supposed by the authors quoted above and with

<sup>1</sup> 'Anatomy of Vertebrates.'

<sup>2</sup> "On some Points in the Anatomy of the Koala (*Phascolarctos cinereus*)."  
P. Z. S. 1881, p. 180.

<sup>3</sup> All measurements are taken by means of a thread laid along the middle of the intestine while adherent to the mesentery.

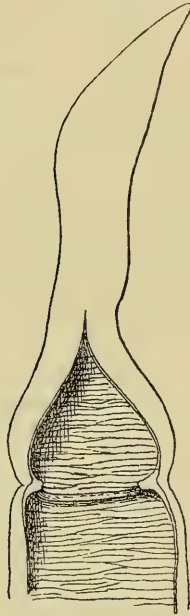
whom I fully agree, it may be asked—why has, then, the *small intestine* become lengthened in the three phyllophagous animals? I think that this may be explained in the following way :—The leaves of which the food of the animals is composed consist not only of cellulose, but contain also protoplasmic, amylaceous, and other substances, which ought to be digested and re-absorbed in the small intestine. These substances are, however, all of them enclosed within the membranes of the cellules of the leaves, and these membranes are more resistant than, for instance, the thin-walled cellules composing the pulp of fruit. The food derived from leaves must consequently be subjected to a longer treatment also in the small intestine, before yielding its useful substances, than food consisting of fruits needs—not to speak of animal food.

The small intestine of *Trichosurus* is villous, as has already been remarked by Oppel<sup>1</sup>, but my material does not allow any description of the villi. About 93 cm. from the opening into the large intestine I have found two roundish Peyer's patches, situated near each other and measuring respectively 3 and  $2\frac{1}{2}$  mm. in diameter. They are solid and not composed of small nodules. In the intestine of the Koala there are no Peyer's patches according to Forbes (*l. c.* p. 184). The last portion of the ileum is in *Trichosurus* conspicuously more thick-walled than other parts of the small intestine. Its mucous membrane forms distinct longitudinal plicæ, and it seems thus to be more rich in glands than other parts. In addition to this there are to be seen what I am inclined to term, with Owen, some "wide and deep glandular fossæ." The largest of these is situated about 1 cm. from the ileo-cæcal opening, and measures nearly 5 mm. in length by  $1\frac{1}{2}$  in width. About 1 cm. higher up the ileum there is another one of the same kind although smaller, so that it measures only 2 mm. in length. There are also indications of some other depressions, but they are shallower and less distinct. My material does not allow of any histological investigations, but I hardly think I can be much wrong in interpreting these as accumulations of glands. The "fossæ" mentioned by Owen in the words quoted above were found by him in the large intestine of the Koala, and are thus not homologous with these. The "fossæ" found by Owen have, however, their homologue in a thickened glandular area, with numerous shallow depressions, situated on the adjoining borders of the colon and the cæcum of *Trichosurus* just opposite the ileo-cæcal opening. The ileo-cæcal valve is well developed and protrudes into the colon. The limit between the colon and the cæcum is only marked by a short plica from the ileo-cæcal valve and a weak *sphincter cæco-colicus*. If this sphincter is weak it is assisted in its functions by a series of cæcal sphincters which are strongly developed. Their number is four. The first is situated about 3 cm. from the cæco-colic one. The next is stronger and found at about the same

<sup>1</sup> 'Lehrbuch d. vergl. mikroskopischen Anatomie der Wirbeltiere,' Zweiter Teil (Jena, 1897), p. 288.

distance from the first. The third, which is almost the strongest lies still 4 cm. nearer the blind end. The fourth, which is about equal to the third in strength, is situated at a distance of about 8 cm. from the tip of the distal end. These two last-mentioned sphincters are  $3\frac{1}{2}$  to 4 mm. thick, and protrude in the preserved state, as circular valves 3 mm. or more, into the lumen of the cæcum; and there is no doubt that in the living animal they are capable of entirely shutting off one portion of the cæcum from the other, thus retaining the enclosed food during a suitable time

Text-fig. 4.

Cæcum of *Trichosurus vulpecula*. Nat. size.

for decomposition. The walls of the cæcum increase considerably in thickness towards its blind end; and it is evident that this increase includes the muscular coat as well as, and that especially, the glandular layer. This is the reason why the sphincters also must have an increased size and strength towards the blind end. The mucous membrane of the cæcum is, at least from the third sphincter and onwards, transversely plicated, the plicæ becoming more prominent towards the blind end. They do not extend, however, as simple plicæ all round the cæcum, but the ridges anastomose now and then so that they form a network with

transversely very much elongated, but longitudinally quite narrow, meshes.

The figure (text-fig. 4) represents the blind end of the cæcum from the last sphincter, and shows also the transverse plicæ described above.

When the cæcum is filled the blind end seems to taper to a point not unlike a vermiform appendix.

The colon is thin-walled and smooth, only showing, in places where it is contracted, longitudinal folds, which become effaced by stretching.

From this description it will be evident that the cæcum of *Trichosurus* is an organ which has become to a considerable degree specialized for digestion (and re-absorption). When the chyme passes through the terminal portion of the ileum it becomes mixed with the secretion of the glands of that intestinal tract, to which is added, when it enters through the ileo-cæcal valve, the secretion from the cæco-colic glandular patch. Thanks to the sphincters and the well-developed muscular coat of the cæcum, the food can be moved backwards and forwards, or retained in the cæcal divisions, and then be subjected to the action of the glands through the development of an increased surface due to the transverse plicæ. This great specialization gives a satisfactory explanation why the cæcum of *Trichosurus* does not need to grow out to such a size and attain such a capacity as that of the Koala. It might be questioned whether any proofs can be given to show that cellulose is really decomposed and digested in the cæcum of this animal. It may then, firstly, be referred to the peculiar structural specialization described above; secondly, it may be stated that the contents of the colon which have passed the cæcum seem to indicate such a digestion. There may still be recognized remains of the most resistant parts of the vegetable tissue, such as pieces of epiderm, isolated sclerenchym-cells, bundles of vessels, etc.—all of them looking as if they had been cleaned by some reagent, so that only the hardest “skeletal” parts were left. There are also to be seen the spiral threads, these being the only remains of spiral vessels, the thin walls of which probably have been digested. But I could not detect any parenchymatous cells or other softer parts. I think, therefore, that it may be admitted that the softer cellulose has been decomposed and digested, leaving only the more or less lignin-like substance.

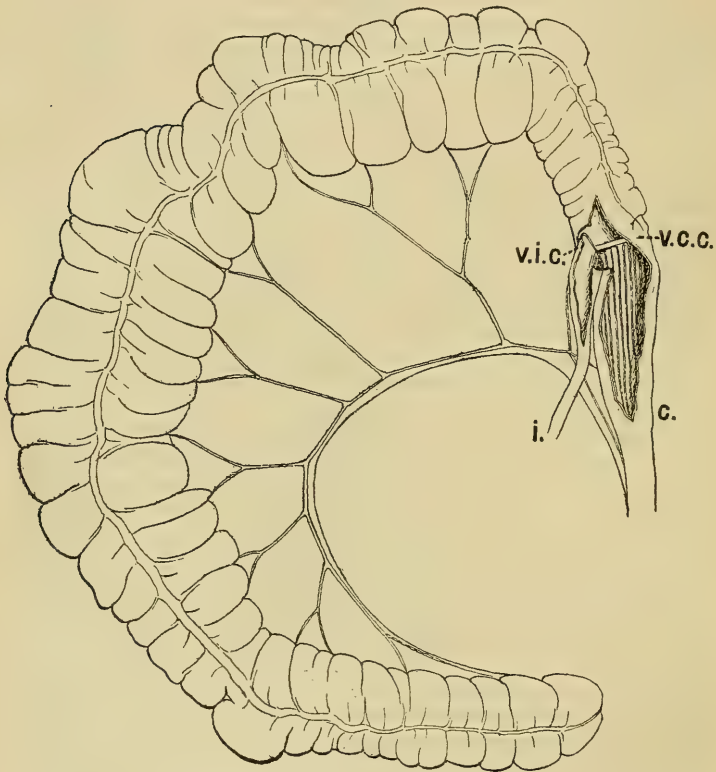
In *Pseudochirus* the small intestine is, as usual, thin-walled and villous but otherwise smooth. The walls of the ileum do not seem to show any increase in thickness. The ileo-cæcal valve (*v.i.c.*) is well-developed, and from it extends as a transversal fold a cæco-colic valve (*v.c.c.*) and sphincter, as may be seen in the figure (text-fig. 5, p. 18).

Close by, but on the colic side and also near the ileo-cæcal valve, a brownish glandular patch is seen, homologous with that described above and in a similar situation in *Trichosurus*. (It is



not represented in the figure.) The cæcum of *Pseudochirus* is a good deal larger than that of *Trichosurus*, as the above-recorded comparative measurements indicate, and offers also quite another aspect (compare figures). It is provided with two very strong tæniæ, which continue to the blind end of the cæcum. These tæniæ have an average breadth of 3 mm. and extend one on each side. By means of these tæniæ and the mesentery the wall of the cæcum is folded so that it forms three series of sacculi.

Text-fig. 5.

Cæcum of *Pseudochirus occidentalis*. Nat. size.

c., colon; i., ileum; v.c.c., cæco-colic valve; v.i.c., ileo-cæcal valve.

Through this the effectiveness of the cæcum as a digesting organ is greatly increased, the more so as the depth of the pockets is comparatively great. The end of the cæcum in this animal is bluntly rounded, and thus different from that of *Trichosurus*. The first part of the colon is longitudinally plicated, but the plicæ are not strongly developed and soon disappear.



The digestion in the cæcum seems to be rather complete, since at a distance of 25 cm., more or less, from the ileo-cæcal valve the faecal matter is already formed into balls. A microscopical investigation of these faecal remains shows that they are chiefly composed of pieces of thick-walled epiderm, bundles of vessels, isolated prosenchyme-cells, and similar matter. But the softer vegetable tissue has disappeared and the spiral threads of the vessels are isolated, indicating a digestion of the substance that once formed the walls.

The intestine of the Koala has been described, as already mentioned, by the authors quoted above. Only a few remarks will therefore be made here concerning the intestine of a marsupial fœtus of this species measuring about 9 cm. in length. Its small intestine measured about 37 cm., the cæcum 8.5 cm., and the large intestine about 29 cm. The length of the three different parts of the intestine, compared with the length of the fœtus itself, is thus expressed by the following percentages: 411, 94, 322. If these now are compared with the corresponding ones from a grown animal, calculated from Forbes's measurements (see above), the difference is quite striking with regard to the cæcum and the large intestine. The former is proportionately only about a third as long in the fœtus as in the full-grown animal, and the latter less than half as large in the fœtus as in the adult. The difference of the small intestine of both stages is not so great, that of the fœtus being about four-fifths of the same in the adult. It is also to be remarked that in the fœtus the small intestine is considerably longer than the colon, but in the adult the reverse condition prevails. These differences can of course be ascribed to the difference of the diet of both stages. The milk food of the fœtus is chiefly or completely digested in the small intestine, but the vegetable diet of the adult needs a greatly developed cæcum and colon. The longitudinal folds of the cæcum and the colon are, however, already developed in the fœtus.

The condition found in the Wombat is very peculiar. The narrow opening of the ileum protrudes, surrounded by an "ileo-cæcal" valve, into the colic cavity. This valve has very broad lips, and within the same opens the lumen of the "processus vermiformis" (Owen), only separated from the opening of the ileum by a septum—that is, in other words, the terminal portions of the vermiform appendage and of the ileum are thus fused together into one structure protruding into the colon; both open with separate orifices, which are, however, surrounded by the lips of the same valve. The glandular patch described above as situated near the *valvula cæco-colica* in the related Phalangerids is found in this animal too, but extends partly on to the outer side of the "ileo-cæcal" valve itself already mentioned. From this latter valve plicæ extend on two sides. These plicæ seem to stand in the same kind of connection to the ileo-cæcal valve as in normal cases the cæco-colic valve does. But they do not extend

transversely in the colon as the latter is apt to do, but longitudinally, so that one plica extends down the colon, the other in an opposite direction on the other side. I am, however, inclined to think that these plicæ morphologically correspond to the more or less developed cæco-colic valve of other related forms. Although the direction is different the connection with the ileo-cæcal valve may decide in favour of such an interpretation. These plicæ do not form any boundary between the cæcum and the colon. They form no boundary at all directed as they are now. But how could they get such a direction? I think this may be explained in connection with the shape of the cæcum. Owen, in describing the intestine of the Wombat, used the following words:—"The cæcum is extremely short but wide; it is remarkable for being provided with a vermiform appendage."<sup>1</sup> Later authors have adopted this same interpretation, but I hardly think it is right. If it had been a true vermiform appendage, that is, the reduced blind end of a cæcum, it ought to have opened into the cæcum of which it itself was a part. But it does not, as has been already stated above. It opens with a quite independent opening of its own near that of the ileum. I judge from this that the so-called *processus vermiformis* of the Wombat represents a rudiment of the whole cæcum. If we assume that a moderately developed cæcum should for some reason or another become reduced to a mere appendage, it must acquire a similar situation and open into the colon close to the ileum. It might then easily happen that the wall of the terminal portion of the rudimentary cæcum became fused with the wall of the ileo-cæcal valve. Such an event might be the more easily effected as the shortened mesentery of the cæcal rudiment would draw the latter more and more to the ileum and make both more closely connected. It would also be more convenient if the two openings into the colon lay near each other and were parallel in direction, because there would then be less risk of particles of food entering the cæcal rudiment. I believe, indeed, that such a retrograde development has really taken place, and that in the ancestors of the Wombat the cæcum has been reduced to a rudiment, which might happen if they lived on such a diet that the cæcum was not needed for the digestion of the food. When the cæcum had already reached a considerable degree of reduction, the diet of the animals was changed, and they began by-and-bye to feed on harder and less easily digestible vegetable matter containing cellulose, etc. The cæcum was now, however, so rudimentary that it could not, as in other related forms which live on a similar diet, help in the digestion of this food-stuff. This function became, therefore, the duty of the colon alone, which in consequence had to be considerably enlarged. It grew in strength, and its capacity increased so that it would be able to hold the greatly augmented amount of the less nourishing food that was needed for the sustaining of life and growth. The colon was then distended by the large quantities

<sup>1</sup> Owen: 'Anat. of Vertebr.' p. 417.

of food-material, and the mechanical pressure of this heavy load might have produced expansions, which, if localized, formed bags or sacculi. The first part of the colon might be expected to have been strongly affected by this pressure. It is consequently natural that some wide sacculi should be formed there, and it is these distensions which have been described and figured by the authors as cæcum, although they are derived purely from the colon. It is also easy to understand that when this distension took place the originally transverse cæco-colic plica was drawn or turned out of place to its present longitudinally-running direction.

That the mechanical pressure of the contents of the colon has really played important parts in transforming it to its present shape, may also be proved by another fact. By a broad band opposite the mesentery the colon is sacculated, which, of course, is also an adaptation to its function. At the place where the colon is most closely, by a very short mesentery, soldered to the back of the abdominal cavity, the pressure of the contents would, thanks to this fixation, be more effective. There has thus been formed two large sacculi, which give the colon at that place a size amounting to twice that of its usual width. The shape and size of these sacculi are identical in two specimens which I have seen. This confirms the correctness of the statement; and I think it is these which Owen means when he says: "One of these sacculi was so much longer than the rest as to almost merit special notice as a second cæcum."

Peyer's patches of comparatively large size, 1 to 2 cm. in diameter, are scattered in considerable numbers in the walls of the colon, especially in its middle parts.

The material which I have used for this study has long been preserved in spirit, and the measurements are perhaps therefore not so much to be relied upon. It may, however, be mentioned that the small intestine measured in one specimen about 410 cm., the cæcal rudiment 6 cm. from its blind end to its opening, and the large intestine 840 cm. The "secondary cæcum" is situated nearly at the middle, or 430 cm. from the end. Even if these measurements are imperfect in the detailed statements, they show satisfactorily that the large intestine has been strongly developed. Probably it is fully eight times the length of the animal, or even more than in the Koala.

The interior surface of the duodenum in *Phalanger* shows very plainly a reticulate structure, larger primary and smaller secondary plicæ may easily be distinguished. It offers thus some faint resemblance in appearance to the structure of the reticulum of a ruminant. The plicæ are in both cases formed by coalescence of papillæ. The villi of the intestine are well developed on the ridges forming the network, but some are also scattered in the interspaces. Lower down the small intestine this reticulate structure is less conspicuous, but my material is not in such good condition that I can say where it entirely disappears. The jejunum appears, however, quite smooth.

As in *Trichosurus*, the small intestine of *Phalanger* is provided with at least one Peyer's patch. It is in the specimen before me situated 74 cm. from the cæcum, and measures 30 mm. in length by 13 in breadth, being composed of a great number of small nodules. There are, however, probably more than one Peyer's patch normally in the small intestine of the Cuscus, since Cunningham observed no less than nine in his specimen described in the 'Challenger' report. Some of these were, however, "a mere speck." The terminal portion of the small intestine shows some longitudinal folds, but these are probably not permanent as they disappear by transverse stretching. The ileo-cæcal valve is well developed and protrudes 12 to 14 mm. into the cæcum. From this valve extends on both sides a fold—the cæco-colic valve. At the ileo-cæcal valve it is about 7 mm. in height, but gradually diminishes; about 1 cm. from the valve it passes into the muscular thickening which forms the cæco-colic sphincter. The communication between the cæcum and the colon may thus be completely shut off by means of the incomplete cæco-colic valve and by contraction of the cæco-colic sphincter. When such a shutting-off is effected it seems as if the opening of the ileo-cæcal valve would be directed into the cæcum, and the function of the above-described cæco-colic valve may partly be to brace the ileo-cæcal valve so that it shall not be compressed and closed when the cæco-colic sphincter contracts. But, as it is arranged now, the contents of the small intestine may pass directly into the cæcum without risk of slipping down into the colon. On the cæcal side of the valve there is an area on which the mucous membrane is provided with a considerable number of small depressions. These are about 1 mm. in diameter, and correspond, no doubt, to the glandular patch with similar depressions which has been described above in the phyllophagous *Phalangerids*, although the situation is a little different in these latter, in which this patch is found on the colic side of the valve. Cunningham does not mention this glandular patch in his description of the intestine of the Cuscus.

The width of the cæcum is different at different places. It is at first about 4 cm., then widens to 6 cm., but soon becomes constricted to only  $2\frac{1}{2}$  cm., widens again to  $5\frac{1}{2}$  cm., then it is constricted to  $2\frac{1}{2}$  cm., and again widened to 4 cm., which condition is once more repeated, and then it finally tapers towards the end, which terminates in a digitiform appendix 2 cm. in length by 4 mm. in thickness. Cunningham<sup>1</sup> has in the same species only observed that the cæcum "tapers uniformly." The appendix is hollow and filled with the contents of the cæcum. Its walls are thicker than those of the ordinary cæcum, and it might be a lymphatic organ, which perhaps might be compared with the one of similar situation in the common rabbit.

The cæcum of *Phalanger* is somewhat sacculated by means of

<sup>1</sup> "Report on the Marsupialia," Rep. Scient. Results 'Challenger,' Zoology, pt. xvi. p. 161.



mesenteric bands of muscular fibres which are most often longitudinally, but sometimes obliquely, arranged. Such bands are found on both sides of the cæcum. The interior of the cæcum shows at the constricted places slight longitudinal folds, which, however, probably are of a temporary nature. They are thus not to be compared with the longitudinal folds described in the Koala by Owen and Forbes (*l. c.*).

In the large intestine of *Phalanger* there are some longitudinal folds near the upper sphincter. They are, however, quite short and continue but a few centimetres from the ileo-cæcal valve, and are therefore quite unlike the longitudinal "*valvulae conniventes*" described in the Koala by the authors just mentioned. The colon tapers abruptly from the width of the cæcum  $4\frac{1}{2}$  cm. to  $2\frac{1}{2}$  and then to  $1\frac{1}{2}$  cm. In places where it is much distended its width may reach 3 cm., but as a rule it is less than that of the small intestine, usually  $2-1\frac{1}{2}$  cm.<sup>1</sup> The rectum attains a width of  $2\frac{1}{2}$  cm., and is provided with about half a dozen longitudinal folds, plainly conspicuous, but not much developed. They may, however, be regarded as homologous with those of the Koala in a corresponding situation and of nearly the same number, according to Forbes. The non-digestible remains in the colon of *Phalanger* consist of pieces of epiderm of fruit, prosenchymatous fibres and vessels. The main mass of the fruit-pulp is, however, so decomposed that its particles cannot be identified.

The duodenum of *Petaurus* is very densely beset with flattened more or less tongue-like villi which are transversely arranged and partly form thin denticulated lamellæ. They lie so close together that the contents of the intestine probably only, or at least chiefly, come into contact with the tips of the villi—a condition found by Oppel (*l. c.* pp. 288–9) in *Trichosurus*. In *Petaurus* the small intestine is beset with villi through its whole extent, although they decrease in size posteriorly. The condition found in *Acrobates* seems to be essentially the same. In *Petaurus* the duodenum forms a much more distinct loop than in *Phalanger*; it is 3 cm. in length, the ascending branch being closely connected with the descending one and returning along the same to the pyloric tract. In the latter the duodenal loop is less pronounced because the ascending branch is only half as long as the descending one.

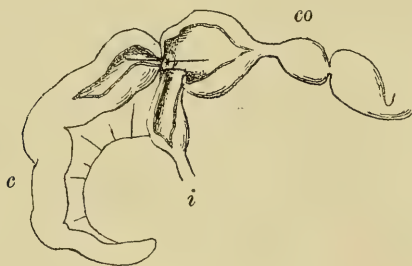
In *Petaurus* the connection between the large and small intestine takes place in such a manner that the ileum opens into the colon, into which the *valvula ileo-cæcalis* (the name is thus not quite suitable in this case, more correctly *v. ileo-colica*) protruded about 2 mm. Close to this valve there is between the cæcum and the colon a strong sphincter, partly like a valve protruding into the cavity of the colon and only leaving a very narrow opening (which, of course, also can be closed) between the same and that of the cæcum.

<sup>1</sup> All such measurements are taken across the empty but not opened intestine.



It is thus evident that the contents of the ileum must pass into the colon, and from there, when the sphincter mentioned above relaxes, into the cæcum. It is also evident that no large pieces can pass through the narrow opening into the cæcum. A comparison between the contents of the colon proves this statement completely. A sample of the contents of the colon taken 2 cm. from the ileo-cæcal valve consists chiefly of large pieces of the chitinous integument of insects, setæ of such animals, etc. A sample from the cæcum consists only of the tiniest particles which cannot be measured or identified. The narrow opening between the cæcum and the colon serves accordingly as a filter. The large indigestible remains are kept back in the colon, the fluid and the fine particles suspended in the same pass into the cæcum, where, no doubt, an absorption of the fluid takes place, after which the indigestible remains are forced back to the colon to be expelled with the fæces. The function of the cæcum may thus be termed absorbing and desiccating. The large intestine acts nearly in its whole extent as a rectum, as the faecal matter is already formed into balls at a distance of only 2 cm. from the ileum (text-fig. 6).

Text-fig. 6.

Cæcum of *Petaurus breviceps*.

c, cæcum; i, ileum; co, colon. *Valvula ileo-colica* is seen to protrude into the colon, and a bristle is inserted through the narrow opening of the cæco-colic sphincter.

In *Phalanger*, on the other hand, it can be assumed with certainty that the cæcum has a digestive function, which may be concluded from the fact that it is provided with large glands. The great length of the colon makes it probable that it has digestive as well as reabsorbing powers.

The dimensions of the different tracts of the intestine in a marsupial young of *Petaurus breviceps*, measuring 63 mm. in total length without tail, were as follows:—Small intestine 185 mm., cæcum 17 mm., and large intestine 43 mm. If these measurements be compared with those of the young animal itself (without tail) the relation is expressed by the following percentages:—290, 26, and 68. From this it may be seen that all three parts are

somewhat shorter in the young than in the adult. The difference is, however, not so great as in the case of a marsupial fœtus of the Koala already mentioned. Although the latter represented a younger stage<sup>1</sup>, the conclusion can thus be drawn that the milk diet of the young *Petaurus* differs, with regard to its composition and therefrom resulting influence on the intestine, less than it does in the case of the young Koala. It is also of interest to note that in the young *Petaurus* the cæcum stands in quite open communication with the colon. That is because the sphincter is not needed yet for the purpose of prohibiting any indigestible remains from entering the cæcum as in the adult.

In *Acrobates* the arrangement of the connection between the small and the large intestine is the same as in the adult *Petaurus*. The ileum opens with its valve protruding like a mouthpiece into the colon; and there is a very strong constriction between the latter and the cæcum. Although the stomach in my specimen of *Acrobates* was empty, I think it may be assumed that it lives on a similar diet to *Petaurus*; and at any rate the function of the cæcum seems to be perfectly alike in both animals.

The small intestine of *Acrobates* is comparatively shorter even than that of *Petaurus*. In the latter and in *Phalanger* the length of the small intestine is comparatively not much different. This may be understood as meaning that that part of the food-material which ought to be digested in the small intestine of *Phalanger* is not difficult to digest. It may chiefly consist of the juice and other contents of the soft parenchymatous cells of the fruit-pulp. This matter is, of course, more easily accessible for the digestive organ than is the material contained in the better protected cells of the leaves etc., which form the food of the animals considered above, and the small intestine of which, therefore, has become lengthened.

As the last stage in this series, showing a different development of the intestine and especially of the cæcum in accordance with the different diet, *Tarsipes* may be mentioned; this animal has, as already remarked, entirely lost its cæcum, because such an organ is superfluous for a honey-eater.

The general arrangement and structure of the dentition of these animals indicate that also with regard to those parts adaptations for different purposes have taken place. The dentition of *Phascolumys* is evidently most specialized. Its incisors are more reduced in number than in the others, the canines are absent, and the molars have persistent pulps. The latter are also curved in such a way that the upper molars are laterally concave and the lower ones are laterally convex. This development and shape

<sup>1</sup> The Koala fœtus was still naked. The young *Petaurus* was beginning to become hairy, so that, for instance, the dark vertebral stripe was well conspicuous, but the hairs of the tail were not yet prolonged. It had certainly not yet partaken of any other food than milk, because the mandibular incisors, although protruding 3 mm. from the sockets, had not cut the gum.

of the molars reminds one of the same in the Hares and Rabbits. In his above-quoted work Tullberg has already drawn attention to this parallelism. The explanation given by that author of the development of persistent pulps in the molars holds good for the Wombat as well. He believes that such teeth have been developed chiefly in animals which feed on hard and tough roots. Such animals must take much sand into the mouth when feeding, and the sand must act strongly upon the crowns of the molars in the act of grinding. This renders persistent growth necessary. That the food of the Wombat consists mainly of roots is a well-known fact; and a glance at the crowns of the molars suffices to show the marks of the sand as transverse scratches. Although the molars of the Wombat in their general shape resemble those of a Rabbit, the chewing must take place in quite a different manner in both forms<sup>1</sup>, as can be seen from a comparison of the structure of the mandible in both animals.

The dentition of the Phalangerids has been described by Flower and Lydekker in their valuable manual<sup>2</sup>. They have drawn attention to the "crescentoid" cusps of the molars in *Pseudochirus* and in the Koala "recalling those of the Selenodont Artiodactyle Ungulates." This "subselenodont" dentition is, of course, very suitable for phyllophagous animals. It becomes the more effective because the distance between the upper molar series is greater than that between the mandibular molar series, so that the outer row of cusps of the latter fit in between both rows of the upper. Through this arrangement the jaws get as it were a cutting-power, and when the lower jaw is moved sideways the sharp enamel ridges have a great power of tearing and grinding the food. It is, in fact, evident that the chewing of the food takes place in the following manner:—The lower jaw is moved towards one side so much that the outer margin of its molars corresponds to the outer margin of the upper molars. If, then, both jaws are pressed hard against each other the lower jaw must glide, with triturating effect, in a median direction—in consequence of the fact that the main surface of the upper molars slopes inward—till the outer cusps of the lower molars fit in between both series of cusps of upper molars as described above. Then the same movements are repeated again on the same or the other side. The movements of the jaws in the act of chewing may thus be compared with those in the Ruminants—as might be expected seeing that the teeth have a similar structure and position.

The incisors in these two animals are different in shape. In the Koala they are comparatively narrower than in *Pseudochirus*. The compressed mandibular incisors glide with their bevelled ends inside the upper median incisors, and work against the second pair of upper incisors; the latter in their styliform shape

<sup>1</sup> This is also remarked by Tullberg (*l. c.*).

<sup>2</sup> An Introduction to the Study of Mammals. London, 1891.

and situation behind the first pair remind one of those of the duplicitentate rodents. The incisors in this animal serve thus to nip off pieces of the leaves. In *Pseudochirus* the lower incisors are broad and have sharp cutting-edges also on the sides. They therefore work together with the upper incisors as a pair of scissors cutting off pieces of plants and leaves. Both halves of the mandible are in this animal movable, whereby the cutting-power of the lower incisors becomes more effective. They may thus be compared in shape and in action with those of the Kangaroos.

In *Trichosurus* the incisors are intermediate in shape between those of the two animals just referred to. They are broader than in the Koala, but have a cutting-edge only in front. In two skulls of this animal before me it is plain that the lower incisors, when used, are able to work against all three pairs of upper incisors, which are all worn—the median ones, however, in such a manner that a sharp edge is left in front. The two halves of the mandible do not seem to be movable.

The subselenodont type of the molars is not so prominent in this animal—at least not when the teeth are worn. The shape and position of the molars seem also to be different in *Trichosurus*, because, at least in the specimens before me, the surface of the two anterior upper molars slopes inwards and that of the two posterior ones outwards. In the lower jaw, in correspondence herewith, the two anterior molars slope outwards and the two posterior ones inwards. The crown of the posterior premolar in each jaw slopes in the same direction as the anterior molars of the same series close to which it is situated. In consequence of this arrangement, the upper premolar and the anterior upper molars effect the gliding in a median direction of the lower jaw when both jaws are pressed against each other in the manner described above; but the posterior upper molars arrest the lower jaw and hinder it from gliding further than to its normal position. In connection herewith is also to be observed that the mandibular molar series of *Trichosurus*—thus differing from the Koala and *Pseudochirus*—have not a shorter distance *inter se* along their whole length than the maxillary molar series. In *Trichosurus* the molar series of both jaws are, posteriorly, almost opposite each other, and only anteriorly have the mandibular molars a more median position than the upper molars. This accounts for the different direction of the anterior and posterior molars.

The teeth of a young *Phalanger* differ a great deal from those of the old one of the same species. In the half-grown animal the lower incisors appear to be absolutely broader than in the adult. This is, however, only apparently the case. The breadth is about the same in both. The incisors of the young are thus not only comparatively broader, but their shape is also different. They are much more flattened than in the adult and have sharp lateral edges, so that they resemble the corresponding teeth of *Pseudochirus* described above, or of a Kangaroo. The resem-



blance is the greater because they have a more horizontal direction than in the adult, in which latter they are also stouter, compressed, and only provided with an edge at the end. In the young the lower incisors, on account of their shape, work against the two median pairs of the upper incisors when the jaws are shut. In the adult they work only against the inside of the median pair of upper incisors when in a normal situation close to each other. The halves of the lower jaw are, however, movable, more so in the young than in the adult. This, together with the sideways movements of the lower jaw, explains also why the second pair of upper incisors are worn. The faculty of moving the mandibular halves so that the lower incisors may be separated from each other in the act of biting is, of course, very useful in many cases<sup>1</sup>. Thus, for instance, the animal is capable of securing a much larger piece of some soft fruit<sup>2</sup> in one bite through this arrangement, and when occasionally preying upon animals or birds this faculty is also of importance. The mobility of the mandibular halves consequently serves here other purposes than in the Kangaroos and *Pseudochirus*.

The upper canines are well developed in young and adult. The molars of the young *Cuscus* show four well-developed pyramidal cusps with radiating ridges, so that, as has been shown by O. Thomas, they resemble in some degree those of the Koala. The enamel of these cusps is, however, less developed in the *Cuscus*, so that they are in the adult animal soon worn down to such an extent that the crown becomes almost even, and only peripherally surrounded by enamel. The teeth are then not much adapted for any grinding action. The situation and different sloping of the posterior and anterior molars are similar to those described in *Trichosurus*. The action of the jaws must consequently be similar, although the enamel is rather less developed. To crush the pulp of fruits and similar matter the teeth are, however, sufficient. The hindmost premolar of both jaws lying just in front of the molar series is somewhat more strongly developed than in *Trichosurus*, pointed and reminding one a little of a canine. Those of the upper and lower jaw do not touch each other as in *Trichosurus*, but the mandibular premolar goes inside and in front of that of the maxillary. This development of the last premolar may have some connection with the alleged occasionally predatory habits of the animal.

In *Petaurus* the median lower incisors are very long and slender. The median pair of upper incisors are longer than the others. They may thus, together with the lower incisors, form a pair of pincers. It is also probable that the mandibular incisors themselves may, because both halves of the lower jaw are quite movable, act as a suitable implement for pinching and scratching

<sup>1</sup> The mobility of the mandibular halves of the Rodents and its causes have been extensively discussed by Tullberg in his work quoted above, p. 345 and following.

<sup>2</sup> Tullberg has stated that Squirrels feeding on mushrooms separate their incisors (*l. c.*).



small insects from their refuge in flowers, in cracks in the bark, and similar places where these slender incisors may conveniently be inserted. When securing larger insects this can, of course, be more easily done with the incisors separated so that they act as a fork, than if they lie close together and form only one point. The molars have four moderately developed bluntly pointed cusps. The lateral row of cusps of the mandibular molars fits in between both rows of cusps of the upper molars.

On the whole the dentition may be said to approach the insectivorous type. The molars can certainly not be used for the grinding of any hard vegetable matter, and the incisors are too weak to gnaw.

In *Acrobates* the development has gone still further in the same direction. The median lower incisors are long and slender, although, if compared with the skull itself, not so long as in *Petaurus*, which has a shorter, less pointed snout. They may certainly serve as pincers and the mandibular halves are quite movable. The premolars of *Acrobates* are much better developed, longer, and more pointed than those of *Petaurus*. When the jaws shut, the premolars of the upper and lower jaws meet, and the latter slide up in front of the former. These teeth may thus help in catching and holding the prey, which is not the case in *Petaurus*. In the latter the premolars and second incisors of the lower jaw are small and functionless. This is because, in consequence of the length of the median incisors and the corresponding shortness of the jaw itself, there is formed a considerable opening between the upper and the lower jaw corresponding to the canine and premolar region of the maxillary. The maxillary teeth thus cannot meet the mandibular teeth, which do not even lie opposite to them. The molars of *Acrobates* are similar to those of *Petaurus*, but their cusps are sharper. It may be in consequence of the arrangement of the premolars and their use that *Acrobates* has been able to reduce its number of molars to 3/3 when *Petaurus* has 4/4.

In none of the Phalangerids which have the rami of the lower jaw movable, as described above, have I been able to detect in my material any trace of such a transverse muscle as that which is found in the Kangaroos at the base of the mandibular incisors, and which has the function of approximating the inner edges of these teeth. In the Kangaroos it is said by Leche<sup>1</sup> that the mandibular incisors are separated from each other by the combined action of the *musculi biventer, mylohyoideus*, and *geniohyoideus*. In his great work on the Rodents already quoted, Tullberg states that *m. masseter* serves to break or bend the lower margin of the mandible outwards, and that in such a case the incisors become pressed close to each other. On the other hand, the *m. transversus mandibulae*, when contracting, approaches the lower margins of the mandibular rami towards the median line,

<sup>1</sup> Bronn : Kl. u. Ordn. d. Thierr., Säugethiere, vi. 5. 1. p. 681.

whereby the incisors become separated. In the *Phalangerids* in question I think that in a similar manner as in the *Rodents* the *masseter* may press the mandibular incisors together, but the *pterygoideus internus* separates them from each other. The *mylohyoideus* seems to be rather weak, and is inserted too high up on the inner surface of the mandible to have any power of bending the lower parts of the mandibular rami inwards and thus separate the incisors. The *pterygoideus internus* is very strongly developed, and the angle of the mandible is much inflected so as to give this muscle a wide area of insertion. It is of interest to see that in those *Phalangerids* which have especially movable mandibular rami, viz. *Pseudochirus*, *Petaurus*, and *Acrobates*, this inflexion is much stronger than in the *Koala* with fixed mandibular rami. This fact gains importance by the observation that in the three former less is done for the enlarging of the area of insertion of the *masseter* on the outer side of the mandible than in the *Koala*, in which the angle is considerably expanded on the outer side.

In *Trichosurus* and the *Wombat*, with immovable mandibular rami, and in *Phalanger*, with the same only a little movable, the angle of the mandible is broadly expanded on both sides for the purpose of giving the powerful muscles a wide area of insertion.

It has been stated above that the *Koala* and *Pseudochirus*, and in a somewhat smaller degree *Trichosurus* and *Phalanger*, must move their mandibles in a lateral direction in the act of chewing, so that the mandibular molars come quite opposite those of the maxillary. This movement must take place in such a manner that the whole mandible makes a slight lateral rotation with the condyle of the same side, towards which the movement is directed, as a fixed point or pivot. This rotation is effected by the contraction of a portion of the *masseter* of the opposite side, that portion which, posteriorly, is inserted to the outer angle of the mandible, and anteriorly to the foremost part of the zygomatic arch or to the maxillary below and in front of the same.

When contracting, this muscle endeavours to pull its posterior point of insertion forwards, which results in a pressing of the whole mandible towards the other side. The result is the more easily obtained the more the outer angle of the mandible is developed, because the lever becomes longer when the posterior point of insertion of the said masseteric portion is situated more laterally—or, which is the same, at a greater distance from the pivot (condyle). The *m. pterygoideus internus* when contracting endeavours to draw up the lower margin of the mandible, or its inner angle, in an upward and somewhat median direction. This action then results in an outward bending of the molar series, and, perhaps, also a slight lateral rotation of the whole mandible, because it is fixed posteriorly. The more the inner mandibular angle protrudes in a median direction, the longer is the lever for

this muscular action. It is thus possible that the movement of the mandible towards one side is effected by the combined action of a part of the *masseter* of the opposite side, and in less degree by the *pterygoideus internus* of the same side. When the mandible has come to the desired lateral position so that the outer margin of its molars comes quite opposite that of the corresponding molars of the maxillary, both *masseters* and *pterygoidei* contract and press the jaws together. The lower jaw then glides back into the normal position, owing to the direction of the sloping surfaces of the molar crowns as described above.

In the true Phalangerids the mandibular condyle which serves as the pivot in the above-mentioned lateral rotation of the lower jaw is steadied behind by the very solid post-glenoidal bone. In the Wombat the condyle is only steadied on the inner side. We may conclude from this that the chewing of this animal takes place in a different manner from that in the true Phalangerids. The sloping of the molar surfaces is also quite different in the Wombat, *i. e.* inwards in the lower and outwards in the upper jaw. In addition to this they are concave with sharp enamel ridges all round, but especially protruding at the inner and outer margins. It seems as if the chewing were effected by alternating transverse movements of the lower jaw, and that the triturating action on each side chiefly takes place when that side of the mandible is moved in a median direction. As my material is not sufficient, however, I shall not make any detailed statements.

*Tarsipes* takes, with regard to its dentition, the same extreme position as it does with regard to the development of its intestine. The mandibular incisors are slender and form together a point, which perhaps might be used in making holes in the corolla of flowers rich in honey for the insertion of the tongue. Together with the upper incisors and canines they may also act as a pair of pincers, useful when the animal catches small insects as it is reported to do<sup>1</sup>. But the well-known rudimentary condition of its molar series—in the specimen before me 2/2 to the left, 3/3 to the right—as well as the weakness of the lower jaw, without a *processus coronoideus* and angular inflection, make chewing or even crushing of any hard prey impossible.

Thus the development and structure of the dentition, as well as of the intestine, show a beautiful correspondence with the diet and habits of the animals in the whole family Phalangeridae, the more striking through the polymorphism within so restricted limits as those of such a natural group.

<sup>1</sup> Conf. Lydekker's 'Handbook,' p. 121 (quoted on p. 13).

3. On the Specimen of the Quagga in the Imperial Museum of Natural History, Vienna. By LUDWIG V. LORENZ, C.M.Z.S.

[Received November 25, 1901.]

(Text-figure 7.)

In the Zoological collection of our Museum there is a striped *Equus* named "*Equus quagga*," and until recently I have always thought it was a Quagga of typical features, though the published figures of that now extinct animal are rather different. But when I visited the museums of Munich, Tring, London, Paris, and Berlin last year, I discovered that the Quaggas which I saw there were not quite in accordance with the specimen at Vienna. I noticed them to be in general of somewhat *different coloration*—more greyish or chocolate-brown on the upper parts, to have narrower and perhaps more numerous dark stripes separated by comparatively *broader* light interspaces, and, moreover, they all appeared to be of a *smaller* size. When I returned to Vienna I asked my friend Marktanner (of the Museum in Graz) to photograph our Quagga, and I had intended to send copies of the photograph to different museums and to get others of the Quaggas there in exchange. But different circumstances prevented me from following the matter up until October last, when I had the pleasure of receiving a visit from Dr. P. L. Sclater; and one of his first questions was, what I thought about our Quagga, as it seemed to him not quite identical with other specimens of this *Equus* known to him. It was a great satisfaction to me that such an authority as Dr. Sclater had come to the same conclusion as I had done, and I am following his invitation in offering to the Zoological Society of London an exact description of our Quagga accompanied by one of the before-mentioned photographs. Before writing this I examined the following figures of the Quagga, which I propose to refer to as I proceed with my description:—

Fig. I.—Buffon's and Shaw's copies of Edwards's plate (Gleanings of Nat. Hist. i. pls. 222 & 223)<sup>1</sup>, though this figure seems to me to represent rather *Equus burchelli*.

Fig. II.—Buffon's and Schreber's copies of Allamand's young Quagga. (Allamand's edition of Buffon, Supplément, v. pl. vi.)

Fig. III.—Geoffroy St.-Hilaire and Cuvier's plate (Hist. Nat. Mammif. pl. 320), also reproduced by Schinz (Säugethiere, "*Equus*," pl. v.).

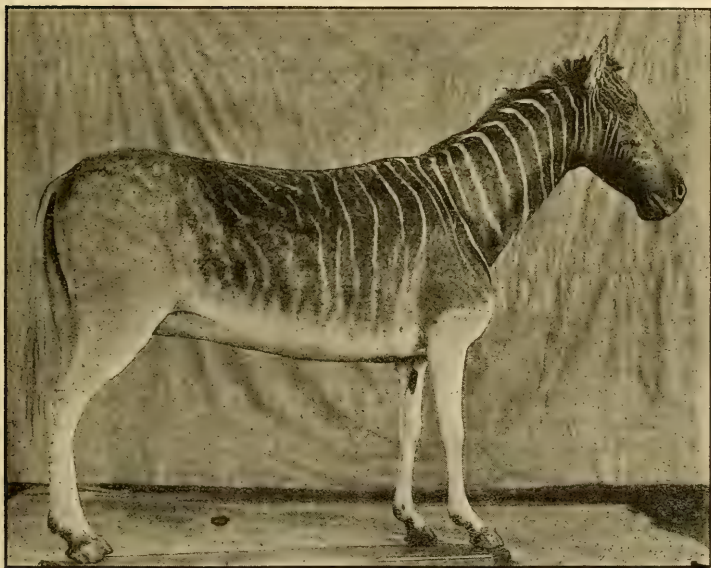
Fig. IV.—Schreber's plate (vol. vi. pl. 317 A), representing the Quagga of Munich acquired by Ecklon about 1835.

<sup>1</sup> Taken from the type of *Equus quagga*.



- Fig. V.—The woodcut in Flower and Lydekker's 'Animals Living and Extinct,' p. 384, fig. 160; copied in W. L. Sclater's 'Fauna of S. Africa,' Mammals, ii. p. 295, fig. 74.
- Fig. VI.—A woodcut in Brehm's 'Thierleben, Säugethiere,' Bd. iii. fig. p. 49.
- Fig. VII.—Noack's drawing (Zool. Garten, 1893, fig. p. 293), taken from the figures in the 'Gleanings of the Knowsley Menagerie,' pl. liv.
- Fig. VIII.—The woodcut in Lydekker's 'Royal Natural History' (vol. ii. fig. p. 507), perhaps representing the specimen now in the British Museum.
- Fig. IX.—The portrait of a Quagga's head in Bryden's 'Great and Small Game of S. Africa,' pl. ii. fig. 2.
- Fig. X.—Copies of York's photographs (P. Z. S. 1901, i. p. 166, fig. 47) of the Quagga in the Society's Gardens in 1870, and two photos of the same animal kindly sent to me by Dr. Sclater.
- Fig. XI.—An original photograph of the Quagga in the Museum at Tring, being the same individual as the last (no. x.).

Text-fig. 7.



The Quagga of the Vienna Museum. (From a photograph.)



*Description of the female Quagga purchased by Ecklon, 1836 (Mus. Vindob.).*

*Measurements in centimetres :*

Total length from upper lip to end of tail, without hair ...	300
Length of the face from nostrils to the beginning of the mane.....	43
Length of the mane.....	76
From end of mane to root of tail .....	128
Tail without hair .....	40
Tail with hair .....	80
Length of ears on the outer side.....	22·5
Ditto on the inner side .....	15
Height at the withers.....	130
Height at the croup.....	139
Fore leg from the elbow .....	71
Hind leg from the heel .....	52
Hoofs, length.....	6·5 & 6
Circumference of hoofs...	23 & 27

*Coloration :*

Ground - colour of upperside clay-brown on the head, creamy buff on the neck, shoulders, and back, gradually changing to buff on the flanks and thighs.

*Breast, underparts, legs, and tail* white. Tail with elongated hair from the root. *Head, neck, back, and flanks* with narrow or broad stripes of yellowish brown passing into chestnut or maroon. Back (haunches) clouded with drab. *Mane* in the middle dark chestnut, ornamented laterally by tufts of whitish hair, ten on each side. *Along the back* in continuation of the mane a dark brown stripe, having a breadth of 3 cm. on the withers, expanding to 12 cm. on the crupper, and growing again narrower towards the tail, on which it extends to a length of 12 cm., terminating with a breadth of

*Remarks on the Description.*

Of all the Quaggas figured as above noted the authors give generally smaller measurements, and the specimens examined by me were all apparently smaller.

Of the figures above cited only figure iii. comes generally near the colour of our specimen, but it is still lighter. Fig. iv. approaches it too, but is darker on the back. In fig. i. the ground-colour is pale chestnut.

The stuffed specimens seen in other museums resemble in their ground-colour fig. ii.

The stripes on the head, neck, and body are darker except those of fig. iii. Edwards's Quagga is described as with black stripes.

In figure x. this band is only to be seen on the croup; the pectoral region of the spine appears to be quite light. Figure iii. shows no dorsal band. The young Quagga of the Cape Town Museum is said to be also without this band.

0.5 cm. only. This dorsal band is bordered on the pectoral region by longitudinal creamy spots, which become more confluent on the lumbar and sacral parts, forming at last continuous undulated lines which vary in breadth from 0.5 to 1.5 cm.

A *ventral band*, beginning with a brownish shade on the fore breast, extends as a dark brown stripe to the umbilicus: its greatest width in the middle of the breast is about 8 cm., it narrows to 2 cm. on the belly.

*Fetlocks* with blackish rings just above the hoofs. *Ears* creamy, brownish at the back in the base, dark clay-colour thence to the end, extreme tips white.

Back of the nose nearly uniform clay-colour, between the nostrils dark brown; lips whitish, chin and throat uniform chestnut.

The dark striping is as follows:—Eight narrow lines run from between the eyes down to the back of the nose and up to the beginning of the mane; from the middle of the front a ninth medial line runs to the back of the nose. From the eyebrows six stripes on each side pass to the top of the head. From the inner corner and lower lid of each eye three indistinct stripes pass towards the nose. On the cheeks upwards from the corner of the mouth are five streaks more or less curved. Next to them four others on each jaw, of which the first makes an angle towards the eye, turning then upwards to the base of ear; while the next two run more directly in this direction, and the fourth embraces the base of ear, ending behind it at the mane. The 2nd and 3rd of these stripes are divided on the left side, the 6th on this side corresponding to the 4th on the right side.

The lateral spots or lines are well marked in figures iv., vii., and viii. only. Edwards's figure (i.) has white along the sides of the spinal band with black spots on it.

This is said to be not present in the young specimen at Cape Town.

These black rings are not to be seen in figures i., ii., iii., iv., and vi., besides being indistinct in others (x.), but they appear on the photograph (fig. xi.). White tips are not observable on fig. ix. The back of the nose is apparently dark in figures iv., vi., vii., viii.

The dark stripes of the head appear very different in the various figures. In fig. i. they are few in number and very narrow, and the interspaces are broad.

On the *neck* there are eight transverse bands, their respective breadths being 2, 3·5, 4·5, 5·5, 5·5, 7, 5, and 3·5 on the right; 2·5, 3, 4·5, 6, 7·5, 9, 8, 4·5 on the left side. The first six of them keep more or less apart, while the seventh and eighth unite in front of the fore-neck. The light creamy interspaces on the neck are very narrow, 1 or 2 cm. only.

From the withers there run first two stripes to the front of the breast, where they join; they are rather narrow above and grow wider beneath. Then a single stripe that might be called a "*shoulder-stripe*" also takes its origin from the withers, and, passing the shoulders, divides into two branches on the humeral region. Inside the angle thus formed are some irregular and less distinct short stripes, of which four or five are directed obliquely upwards and partly unite with three others directed downwards and backwards. On the body there are seven other distinct bands getting more obsolete at the lower bifurcated ends, and confluent at last with the buff ground-colour of the flanks. Of these the first three connected with the longitudinal dorsal band have a breadth of from 6·5 to 8 and from 9 to 10 cm., the interspaces between them being 1 and 1·5 cm. The fourth of these bands sends an oblique branch to the croup, and thus encloses a triangular area of which the dorsal stripe forms a side. Within this there is another broad longitudinal stripe anastomosing twice or three times with the oblique one and also with the dorsal stripe.

The triangles on both sides form

These eight bands and the following two, or the homologues of them, are to be recognized in most of the figures, but they are in general narrower and the interspaces are broader. Fig. iii. comes in this respect nearest to our Quagga, and also does the colour. The stripes on the head and neck in figs. iv. and ix. are much darker. Edwards's Quagga (fig. i.) shows unusually narrow black bands on the neck and broad interspaces, just the contrary to our Quagga.

The bifurcation of the shoulder-stripe is well seen in most of the figures except in fig. iv.

These stripes are not represented in most of the figures.

The vertical body-stripes are different in every figure. On the whole they are narrower and more numerous, besides they do not extend to the haunches.

These oblique stripes are not to be seen in some of the figures (iii., iv., and x.), in others there are spots in their places (figs. i. and vii.)

The saddle is wanting in figs. i.

together a kind of saddle, as is the case in all striped horses of the *burchelli*-group. The fifth band takes an oblique direction throughout, running as well as the sixth over the haunches, both becoming gradually narrower at their upper ends, and not quite reaching the dorsal band.

A seventh, somewhat narrower but still distinct, although twice interrupted, stripe takes a direction from the groin and goes over the haunches to the root of the tail without reaching it. Between the 6th and 7th stripe is an *indistinct* short band. Three or four other oblique and gradually fading stripes are observable on the back of the haunches.

to iv. It may be recognized on v. and vi. and on the photo (xi.), as also the bands on the quarters, but they are not seen in fig. x., which represents the same individual.

This reminds one of *Equus burchelli*.

On comparing the stripes and bands of our Quagga with the pictures of the other Quaggas and with the various forms of the Zebras of the Burchell-group, there seems to me no question that the Quaggas belong to that group. I also have the impression that, in spite of the variability of the marking, the examination of sufficient material would result in ascertaining the existence of homologous stripes in the group above mentioned. From a further careful comparison of all the different figures, and especially of the original picture of Edwards, with the stuffed specimens, or at least with photos of them, we could perhaps obtain sufficient answers to the following questions:—

(1) Is the Vienna Quagga specifically the same as Edwards's Quagga?

(2) Can other so-called Quaggas (as, for instance, those of the British Museum and of the Tring Museum) be identified with Edwards's Quagga, notwithstanding the differences pointed out so exactly by Mr. Pocock? (Ann. Mag. Nat. Hist. ser. 6, xx. p. 37).

(3) Can the Vienna Quagga be identified with the Quaggas of London and Tring?

To these questions I would only reply provisionally that the differences between Edwards's picture and the Vienna, London, Tring, and other specimens are certainly more essential than the differences between the Vienna Quagga on one side and the London, Tring, and other Quaggas on the other. Edwards's Quagga, as already remarked, much resembles *Equus burchelli* in some respects—*e. g.*, in the *black* stripes, well defined on the head and extremely narrow on the neck, and in the tufted tail.

As to the Vienna specimen, it is possible that its characters



may be merely individual, for we find among skins of Zebras from the same locality some with pure black stripes and others with brownish stripes. Besides, the transverse stripes on the body of our Quagga show a tendency to bipartition, and the oblique stripes incline to break up into blotches. There likewise remains the possibility that our specimen has been rather increased in size by the art of the taxidermist. Considering, however, that so many local forms of *Equus burchelli* have been distinguished during the last few years, it is by no means impossible that the Vienna specimen might be ultimately separated subspecifically from other Quaggas.

Vienna, Nov. 20th, 1901.

#### 4. On a further Collection of Mammals made by Mr. Th. H. Lyle in Siam. By J. LEWIS BONHOTE, M.A.

[Received November 19, 1901.]

The following paper gives an account of a further small consignment of Mammals sent home by Mr. Th. H. Lyle from Siam. Although small in point of numbers it contains several specimens of considerable interest, and foremost among these is a fine example of the Siamese Hare, which proves to belong to a species not hitherto described. A specimen of *Sciurus atro-dorsalis*, in immature pelage, and two specimens of *Mustela flavigula* form a valuable addition to the National Collection, and help considerably to the more correct understanding of their respective groups.

##### 1. CYNOPTERUS SPHINX (Vahl).

*Vespertilio sphinx* Vahl, *Skrivter af Naturhistorie-Selskabet*, 4<sup>te</sup> Band, 1<sup>ste</sup> Heft, p. 123 (1797); Bonh. P. Z. S. 1900, p. 191; id. loc. cit. p. 875.

*Cynopterus marginatus* (Geoffr.), Flower, P. Z. S. 1900, p. 341.

a. ♀. N. Chiengmai, 27th Feb., 1901.

##### 2. MUSTELA FLAVIGULA Bodd.

*Mustela flavigula* Bodd. *Elench. Anim.* p. 88 (*ex* Penn.) (1785); Flower, P. Z. S. 1900, p. 333.

*Mustela flavigula* subsp. *typica* Bonh. *Ann. & Mag. Nat. Hist.* ser. 7, vol. vii. p. 344 (April 1901).

a, b. ♂. N. Chiengmai, 28th Feb., 1901.

These two individuals closely agree with the description in my paper quoted above, with the exception that the hind-quarters could hardly be styled "very dark brown"; this apparent discrepancy is, however, merely due to faded pelage, for of the two specimens one is lighter than the other.

I append the measurements taken in the flesh, as they are



slightly at variance with those taken from the dried skin in my former paper :—

	Head and body.	Tail without hairs.	Hind foot (s. u.).	Ear.
<i>a</i> .....	589 mm.	440 mm.	108 mm.	4 mm.
<i>b</i> .....	565 „	435 „	107 „	4 „

### 3. *SCIURUS CASTANEOVENTRIS* GORDONI Anders.

*Sciurus gordonii* Anders. P. Z. S. 1871, p. 140; id. Zool. Res. Yunnan, p. 240 (1879).

*Sciurus castaneoventris gordonii* Anders., Bonh. Ann. & Mag. Nat. Hist. ser. 7, vol. vii. p. 164 (Feb. 1901).

*a*. ♂. Doi Sritepe, Chiangmai, 27th March, 1901.

*Dimensions in flesh.* Head and body 218 mm.; tail 193; hind foot 47; ear 21.

This form has hitherto been recorded only from Upper Burma, but the present specimen agrees perfectly with examples from the type locality.

### 4. *SCIURUS CANICEPS* Gray.

*Sciurus caniceps* Gray (nec Temm.), Ann. & Mag. Nat. Hist. x. 1842, p. 263; Bonh. P. Z. S. 1901, p. 55; id. Ann. & Mag. Nat. Hist. ser. 7, vol. vii. p. 271 (March 1901).

*a, b, c.* ♂ ♀ ♀. Sawankalok, Siam, 27th Dec., 1900.

Two of these specimens are passing into the bright pelage, while the third has fully assumed it.

### 5. *SCIURUS ATRODORSALIS* Gray.

*Sciurus atrodorsalis* Gray, Ann. & Mag. Nat. Hist. x. 1842, p. 263; Bonh. P. Z. S. 1901, p. 55.

*a*. ♀ imm. Chiangmai, Siam, 5th April, 1901.

This specimen, which is about three-fourths grown, differs from the adult in its much greyer coloration, the annulations on each hair being of a very pale grey. The colouring of the ears, however, shows a faint yellowish tinge, and down the centre of the back there is a slight trace of the dark colour characteristic of the adult. The underparts resemble those of the adult.

### 6. *MUS CONCOLOR* Blyth.

*Mus concolor* Blyth, J. A. S. B. xxviii. p. 295 (1859); Bonh. P. Z. S. 1900, p. 195; Flower, loc. cit. p. 361.

*a*. ♂ ad. Chiangmai, Siam, 3rd April, 1901.

*b*. ♀ ad. Chiangmai, Siam, 21st April, 1901.

### 7. *MUS JERDONI* (Blyth).

*Leggada jerdoni* Blyth, J. A. S. B. xxxii. p. 350 (1863).

*a*. ♂ ad. Doi Sritepe, Chiangmai, 15th April, 1901.

*b, c*. ♀ ad. Doi Sritepe, Chiangmai, 16th & 17th April, 1901.

8. *LEPUS SIAMENSIS*, sp. n.

*Lepus* sp. inc. Flower, P. Z. S. 1900, p. 365; Bonh. P. Z. S. 1901, p. 56.

General colour above fulvous and dark brown, the latter colour becoming absent on the hind-quarters and flanks, where the fulvous is slightly tinged with rufous. The whole of the underparts except the lower neck and chest pure white, the line of demarcation being sharply defined. The neck, chest, and limbs are fulvous of varying shades, the colour being deepest on the fore legs, where it is tinged with rufous, and palest on the inner sides of the hind limbs, where it becomes nearly white. Each hair is dull white or greyish at the base, shading into dark brown (seal-brown, Ridgw.<sup>1</sup>) and having a broad subterminal fulvous (buff, Ridgw.) annulation.

On the head the fulvous becomes deeper in colour, and there is an ill-defined whitish stripe running from the nostril to the front of the eye on either side.

The ears, which are but scantily clothed with hair on their outer posterior surface, resemble on the anterior surface the general colour of the back, although the darker tint predominates. The outer anterior and posterior margins are white. At the tip the inner surface is clothed with pure fulvous hairs, while on the external surface the hairs are dark brown.

The tail is dark brown above throughout its length and white underneath, with a slight tinge of buff on the sides.

The skull resembles most nearly that of *L. peguensis*, from which it differs chiefly in the muzzle being slightly broader at its base. The basioccipital bulges outwards and downwards on either side instead of having its sides parallel, thus causing the bullæ to appear at first sight somewhat smaller. The skull as a whole is, moreover, rather larger. Comparing the grooves on the upper incisors with those figured in Dr. Forsyth Major's paper (Trans. Linn. Soc., 2nd ser. Zool. vol. vii. p. 468, 1899), it appears to be most nearly allied to *L. hainanus*, although somewhat intermediate between it and *L. dayanus*. The groove in the species under consideration is moderately broad and nearly rectangular, with a small rounded process jutting out at about the centre of the outer margin.

*Dimensions of type (in flesh).* Head and body 435 mm.; tail 66; hind foot 95; ear 82.

*Skull.* Greatest length 86; breadth of palate at 1st molar 13; length 1st premolar to outer edge of incisors 27; greatest breadth of brain-case 30.

*Hab.* Siam.

*Type.* B.M. 1.7.7.13. ♂ ad. Chiengmai, 16th Feb., 1901.

This fine species is most nearly allied to *L. hainanus* Swinhoe, from which it is easily distinguished by its greater size and the

<sup>1</sup> Ridgway, 'Nomenclature of Colours,' Boston, 1886.

absence of a clearly defined white supra-orbital stripe. From *L. peguensis*, to which it more nearly approaches in size, it differs in the fur on the back and tail being dark brown instead of black, and in the absence both of the ashy tinge on the rump and the black terminal patch on the posterior outer surface of each ear.

The skull of a species of *Lepus* sent home by Mr. Lyle in a former collection agrees with the type skull. The animal to which it belonged was unfortunately destroyed, but Mr. Lyle writes that it was a female, and the following are the measurements in the flesh :—Head and body 463 mm.; tail 74; hind foot 97; ear 84.

For the sake of comparison the measurements of the skulls of *L. hainanus* (type), *L. peguensis*, and the two skulls of this species are appended :—

	<i>Lepus siamensis</i> (type).	<i>Lepus siamensis</i> .	<i>Lepus hainanus</i> .	<i>Lepus peguensis</i> .
	mm.	mm.	mm.	mm.
Greatest length .....	86	89	72	85
Breadth between 1st molars .....	13	13	11	13
Least breadth between orbits .....	13	12	12	13
Length from 1st premolar to outer edge of incisors.	26	27	21	25
Greatest breadth of brain-case .....	30	28	26	28
Height, crown to base of lower jaw ...	54	...	...	53
Greatest breadth of basioccipital .....	10	11	10	9
Posterior breadth of nasals .....	21	21	16	18

# 5. On the Insects of the Order Rhynchota collected by Sir Harry Johnston, K.C.B., in the Uganda Protectorate. By W. L. DISTANT.

[Received November 23, 1901.]

(Text-figure 8.)

The few specimens of this Order collected by Sir H. H. Johnston, and by him presented to the British Museum, are principally interesting as showing that the Uganda Rhynchotal fauna and that of West Africa are practically identical. The species known only from East Africa are very few, and further knowledge may prove them still fewer. Two new species are described, one of which has a far wider distribution than the Uganda Protectorate. I have added notes to the enumeration of each species as explanatory of its geographical dispersion,

## HETEROPTERA.

### Fam. PENTATOMIDÆ.

#### Subfam. SCUTELLERINÆ.

##### CRYPTACRUS COMES.

*Tetyra comes* Fabr. Syst. Rhyng. p. 130. 8 (1803).

*Var.* Dist. Ent. Monthl. Mag. xiv. p. 75 (1877).

Mt. Ruwenzori.

Resembling the variety I described from the Camaroons (*supra*), but with slight traces of an ochraceous subapical fascia to the scutellum. A highly variable and widely distributed species found all over tropical and subtropical Africa.

#### Subfam. DINIDORINÆ.

##### CYCLOPELTA TRISTIS.

*Dinidor tristis* Stål Hem. Afr. i. p. 212 (1864).

Mts. Ruwenzori and Entebbe.

A species hitherto known only from West Africa.

##### ASPONGOPUS LIVIDUS.

*Aspongopus lividus* Dist. Ann. Mag. Nat. Hist. (7) xi. p. 315 (1898).

*Var.* Abdomen above testaceous.

Mt. Ruwenzori.

In typical specimens described from Nyasaland the abdomen above is dark olivaceous. I can, however, discover no other differential characters.

##### ASPONGOPUS NIGRO-VIOLACEUS.

*Pentatoma nigro-violacea* Pal. Beauv. Ins. p. 83, Hem. pl. 7. fig. 4 (1805); Dist. Ent. Month. Mag. xv. p. 10 (1878).

Mt. Ruwenzori.

A species hitherto recorded only from West Africa.

### Fam. COREIDÆ.

#### Subfam. MICTINÆ.

##### ANOPLOCNEMIS TRISTATOR.

*Lygæus tristator* Fabr. Syst. Rhyng. p. 206 (1803).

Mt. Ruwenzori.

A West-African species.

### Fam. PYRRHOCORIDÆ.

#### Subfam. PYRRHOCORINÆ.

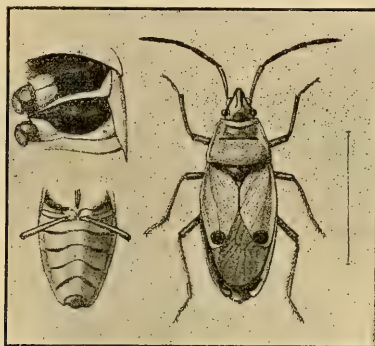
##### ODONTOPUS NOTABILIS, sp. n.

Ochraceous; antennæ black; head, basal joint and base of



second joint of antennæ, and legs reddish ochraceous; scutellum, base of clavus, a round spot near apex of corium, discal area of prosternum, anterior areas of meso- and metasterna, a lateral basal spot behind eyes, two discal transverse lines to pronotum (one curved near anterior margin the other straight near centre), and abdominal segmental incisures (not extending to lateral margins and concolorous on disk), black.

Text-fig. 8.



*Odontopus notabilis*.

First joint of antennæ with a few distinct hairs near base and some hairs at apices of second and third joints, third joint shortest, second and fourth joints subequal in length; corium and clavus very thickly, finely, and obscurely punctate; the black base of clavus coarsely punctate.

Long. 16 to 22 mm.

Entebbe.—The British Museum also possesses specimens from East Central Africa (*G. F. Scott Elliot*); Kavala Island, Lake Tanganyika (*A. Carson*), and Angola.

*SERICOCORIS JOHNSTONI*, sp. n.

Head, pronotum, scutellum, body beneath, and legs ochraceous; lateral margins of pronotum, the corium, and lateral margins of sternum pale purplish antennæ, central longitudinal fascia and basal margin to head, the margins of the anterior area of pronotum, basal margin of scutellum, rostrum, tibiæ, tarsi, and margins of sternal segments, black; membrane pale brownish. Pronotal margins somewhat strongly reflexed; corium and clavus thickly punctate.

Long. 14 mm.

Entebbe.

## Fam. REDUVIIDÆ.

## Subfam. ACANTHASPINÆ.

## PLATYMERIS RHADAMANTHUS.

*Platymyeris rhadamanthus* Gerst. in v. d. Deckens's Reise, iii. (2) p. 419, pl. xvii. fig. 8 (1873).

Baringo, 4000 ft.

A species known only from East Africa.

## HOMOPTERA.

## Fam. CICADIDÆ.

## PLATYPLEURA RUTHERFORDI.

*Platypheura rutherfordi* Dist. Ann. Mag. Nat. Hist (5) xi. p. 173, pl. ii. fig. D (1883).

Entebbe.

A species originally described from West Africa, and since received from Mashonaland.

## Fam. CERCOPIDÆ.

## Subfam. APHEROPHORINÆ.

## PTYELUS FLAVESCENS.

*Tettigonia flavescens* Fabr. Ent. Syst. iv. p. 24. 30 (1794).

Entebbe.

A most variable species distributed over the greater part of tropical and subtropical Africa.

6. On two Collections of Lepidoptera made by Sir Harry Johnston, K.C.B., in the Uganda Protectorate during the year 1900. By ARTHUR G. BUTLER, Ph.D., F.L.S., F.Z.S., &c. ; Senior Assistant-Keeper, Zoological Department, British Museum (Nat. Hist.).

[Received November 12, 1901.]

(Plate I.<sup>1</sup>)

The two collections of which the following is a list were obtained at Entebbe, Port Alice, Port Ugowe, Busiro ; and from Ruwenzori, Toro, and the Congo forest, respectively. The first consignment consisted chiefly of well-known and widely distributed forms ; but the second not only included a good sprinkling of rarities, of species new to the Museum Collection, and even of undescribed species, but was especially interesting from the strange comingling of Eastern and Western types which it contained.

<sup>1</sup> For explanation of the Plate, see p. 51.



Horace Knight del. et lith.

West, Newman chromo.





Among the rare species, *Melinda mercedonia*, *Monotrichtis saussurei*, *Ypthima albida*, *Charaxes bipunctatus*, *Harma hobarti*, *Diestrogyna amaranta*, *Neptis nicomedes*, *Acraea toruna*, *Acraea orinata*, *Acraea oreas*, *Terias punctinotata* ♂, *Belenois solilucis*, *Belenois raffrayi*, *Papilio lormieri*, and *Celenorrhinus opalinus* ♀ are worth special note. The new species are *Harma johnstoni*, *Pseudathyma plutonica*, and *Aphnæus hollandi*: there is also a new moth.

The following is a list of the species:—

1. *Amauris niavius* Linn. Toro, June 16th.
2. " *enceladus* Brown. " "
3. " *albimaculatus* Butl. " "
4. *Melinda mercedonia* Karsch. " "
5. *Tirumala petiverana* Doubl. " "
6. *Monotrichtis perspicua* Trim. Ruwenzori, 5000 ft., Sept.
7. " *safitza* var. *campina* Auriv. Ruwenzori, 4200 ft., Sept.
8. " *saussurei* Dewitz. Ruwenzori, 5000 ft., Sept.
9. *Ypthima granulosa* Butl. " " "
10. " *albida* Butl. " " "
11. *Charaxes numenes* Hewits. Entebbe, April 30th.
12. " *tiridates* Fabr. Toro, June.
13. " *bipunctatus* Roths. " "
14. *Precis boopis* Trim. Port Ugowe, 20th Feb. & 23rd July.
15. " *clelia* Cram. " 20th & 21st Feb.
16. " *cebrene* Trim. " 20th & 22nd Feb.
17. " *westermanni* Westw. Toro, June.
18. " *terea* Drury. Entebbe, April 20th.
19. " *gregorii* Butl. Toro, June 16th.
20. " *chorimene* Guér. Port Ugowe, April 21st & 22nd.
21. *Protogoniomorpha temora* Feld. Toro, June 16th.
22. *Hypolimnas salmacis* var. Drury. Congo forest, July 16th.
23. " *missippus* Linn. Port Alice, 23rd March.
24. *Chloropæa lucretia* Cram. Toro, June.
25. *Harma johnstoni* Butl. Toro, June 16th.
26. " *cænis* Drury. Congo forest, July 4th.
27. " *hobarti* Butl. Toro, June 16th.
28. " *aramis* Hewits. Congo Forest, July 16th.
29. " *theobene* Doubl. " "
30. *Crenis occidentalis* Mab. Busiro, June 2nd; Toro, June 16th.
31. " *boisduvalii* Wllgr. " " "
32. *Euphædra cleus* var., Drury. Congo forest, July.
33. " *inanum* var., Butl. Toro, June; Congo forest, July 16th.
34. " *xypetina* Stgr. Congo forest, July 16th.
35. " *spatiosa* var., Mab. Toro, June.
36. *Aterica galene* Brown. Congo forest, July 16th.
37. *Cynandra opis* Drury. " "
38. *Euryphene abesa* Hewits. " "

39. *Diestogyna amaranta* Karsch. ♀, Toro, June 16th; ♂, Congo forest, July 16th.
40.     "     sp. ? (♀ near *felicia*). Congo forest, July 16th.
41. *Pseudathyma plutonica* Butl. Toro, June.
42. *Kallima rumia* Westw. Toro, June 16th.
43. *Eurytela hyarba* Fabr. Busiro, 5050 ft., June 2nd.
44. *Ergolis enotrea* Cram. Toro, June 16th.
45. *Catuna crithea* Drury.     "     "
46. *Neptis nicomedes* Hewits.     "     Busiro, 5500 ft., June 2nd.
47.     "     *melicerta* Drury. Congo forest, July 16th.
48. *Atella phalantha* Drury. Port Alice, March 20th; Entebbe, April 30th.
49. *Acræa toruna* ♀, Gr.-Sm. Toro, June 16th.
50.     "     *alicia* Sharpe.     "     "
51.     "     *uvui* Gr.-Sm.     "     "
52.     "     *vinidia* Hewits.     "     "
53.     "     *serena*, var. *rougetii* Guér. Port Ugowe, Feb. 20th.
54.     "     *encedon*, var. *lycia* Fabr. Entebbe, April 20th.
55.     "     *onerata* Trim. Port Ugowe, Feb. 20th & 22nd.
56.     "     *natalica*, var. *dissociata* Gr.-Sm. Ruwenzori, 7000 ft., Sept.
57.     "     *zetes*, var. *menippe* Drury. Entebbe, March 20th & April 30th.
58.     "     *orinata* ♀ Oberth. Entebbe, April 30th.
59.     "     *oreas* Sharpe. Toro, June 16th.
60. *Megalopalpus zymna* Westw. Congo forest, July 16th.
61. *Zeltus* ? *antifaunus* Hewits.     "     "
62. *Aphnaeus hollandi* ♂ Butl.     "     "
63. *Cacyreus lingeus* Cram. Toro, June 16th.
64. *Azanius natalensis* Trim.     "     "
65. *Zizera antanossa* Mab. Port Ugowe, Feb. 22nd.
66. *Nychitona medusa*, var. *alcesta* Cram. Entebbe, April 30th.
- "     "     "     *immaculata* Auriv. Toro, June 16th.
67. *Colias electo*, var. *edusa* Fabr. Toro, June.
68. *Terias brigitta*, var. *zoe* Hopff. Port Ugowe, Feb. 21st & 22nd.
69.     "     *boisduvaliana* Mab.     "     "
70.     "     *punctinotata* ♂ Butl. Toro, June.
71. *Catopsilia florella* Fabr. Port Ugowe, Feb. 21st & 23rd.
72. *Belenois solilucis* Butl. Toro, June 16th.
73.     "     *calypso* var., Drury.     "     "
74.     "     *instabilis* Butl. Port Ugowe, Feb. 20th; Toro, June 16th.
75.     "     *formosa* Butl. Toro, June 16th.
76.     "     *severina* var. *infida* Butl. Port Ugowe, Feb. 20th to 23rd.
77.     "     *mesentina* Cram. Port Ugowe, Feb. 20th to 23rd.
78.     "     *raffrayi* Oberth. Toro, July 16th.
79. *Pinacopteryx liliana* Gr.-Sm. Port Ugowe, Feb. 23rd.
80. *Leuceronia argia* ♀, var. *idotea* Boisd. Congo forest, July.
81.     "     *pharis* ♂, var., Boisd. Toro, June.

82. *Eronia dilatata* Butl. Port Ugowe, Feb. 23rd.  
 83. *Papilio polices* Cram. Port Alice, March 20th.  
 84. „ *demodocus* Esper. Entebbe, April 30th; Toro  
     June 16th.  
 85. „ *lormieri* Dist. Toro, June.  
 86. *Eretis perpaupera* Holl. Toro, June 16th.  
 87. *Celaenorrhinus opalinus* ♀ Butl. „ „  
 88. *Baoris inconspicua* Bertol. Entebbe, April 30th.

*New Species, &c.*

HARMA JOHNSTONI, sp. n. (Plate I. figs. 4, 5.)

Nearly related to *H. herminia* of Grose-Smith; larger, with almost the same pattern: the male paler and more olivaceous at base; the pale yellow belt of the secondaries much wider; the blackish macular belt across the disk of the wings rather wider on the primaries and with its inner edge on the secondaries acutely zigzag; the external area less ochreous; the irregular black submarginal line better defined and with long denticles pointing outwards on the folds between the nervures; the yellow lunate band between this line and the discal belt considerably narrowed and partly obscured by dark brown; the external border dark brown, only interrupted by pale yellow patches on the subcostal interspaces in the secondaries, but in the primaries interrupted by small patches excepting on the lower radial interspace: on the under surface the pattern is similar to that of *H. herminia*, but the colouring is less rosy, greyer, the enclosed irregular band limited externally by the straight central line is narrower and becomes uniform with the ground-colour below the subcostal vein. Expanse of wings 72 mm.

The female has the general pattern above of what I regard as *H. herminia* ♀ (an insect nearly related to *H. capella* ♀); the primaries are, however, much more produced at apex and the secondaries at anal angle; the basal area of the wings is much more broadly suffused with ferruginous along the veins, the central blackish band on the secondaries is almost obliterated, only clearly discernible towards the costa, but is followed by a series of indistinctly whitish-edged grey lunules followed by white dots, the submarginal irregular black line being indistinct excepting for the denticles on the folds between the veins: on the under surface, as in the supposed female of *H. herminia*, the pattern and general colouring nearly approach those of *H. lurida* ♀, but with less white on the primaries and with the central line much narrower and red-brown rather than brick-red. Expanse of wings 89 mm.

Toro, 16th June, 1900.

DIESTOGYNA AMARANTA Karsch. (Plate I. figs. 2, 3.)

♀. Dark olive-brown above, irrorated with pale ochreous and banded with the same colour; discoidal cell of primaries with

similar pale-bordered but indistinct markings; a discal increasing oblique belt slightly curved, with sinuated inner edge and diffused outer edge from subcostal to first median vein, from first median vein to inner margin abruptly narrowed and of equal width, slanting obliquely inwards; a chain-like double series of opposed lunules parallel to outer margin; outer border rather paler (because more densely irrorated with pale ochreous) than the rest of the wing: secondaries crossed from just before middle by four pale ochreous bands, the first slightly irregular and sharply defined internally, diffused externally, continuing the discal belt of the primaries; the second and third continuing the chain-like series of the primaries, the fourth submarginal, less defined than the others, undulated; outer border as in primaries. Wings below altogether paler than in the male, greyer, the discal belt of upper surface well defined, but pinky whitish on the secondaries; the basal area of these wings irrorated with pearl-grey indicating two vague subbasal bands; the chain-like belt pearl-grey on both wings and with white points on the upper internal lunules of the primaries and the lower internal lunules of the secondaries. Expanse of wings 56 mm.

Toro, June 16th.

Prof. Aurivillius has pointed out that the female figured by Karsch does not belong to this species and has named it *D. karschi*.

A second female similarly coloured is in the collection; but, without the male, it would be rash to name it: in pattern it is not unlike *D. felicia*, but it is a much shorter-winged insect.

*PSEUDATHYMA PLUTONICA*, sp. n. (Plate I. fig. 6.)

Allied to *P. sibyllina*, but smaller, shorter in wing, the primaries with much less sinuous outer margin, the secondaries rounded, not produced at anal angle; the discal belt of the primaries forming three patches, the first three divisions being much shorter than in *P. sibyllina*; the belt of the secondaries constricted towards costa and not deeply indented externally; the inner submarginal line only white in the centre: on the under surface the markings on the basal area, excepting a costal patch on the secondaries, suffused. Expanse of wings 42 mm.

Toro, in June.

*ACRÆA ORINATA* Oberthür. (Plate I. fig. 1.)

♀. This is the largest female of the group yet described, and much more nearly resembles the male of *A. parrhasia* than anything else: the primaries show a pinky-white, semitransparent, oblique, trifold bar beyond the cell in continuation of the discal tawny belt, and the basal area of the secondaries is almost wholly black: on the under surface this sex chiefly differs from *A. orinata* ♂ in showing a diffused whitish patch beyond the cell of primaries. Expanse of wings 70 mm.

Entebbe, April 30th.



I once supposed that *A. orinata* would prove to be a variety of *A. oppidia* ♂, and Prof. Aurivillius believed it to be a form of *A. orina*, but we were both wrong; it is a good distinct species.

*APHNÆUS HOLLANDI*, sp. n. (Plate I. fig. 7.)

♂. Nearly allied to *A. orcas*; but the metallic colouring of the upper surface more brilliant and rather emerald-green than greenish blue; the black cell-spots on the primaries are considerably larger and the apical area is black with scarcely a trace of metallic scaling, the subapical series of spots (of which only the two uppermost are clearly visible) reduced to a few metallic scales; on the secondaries the metallic patch extends closer to the outer margin, the apical area is browner, and the marginal spot between the tails is ochreous instead of red: on the under surface the differences are much more marked; the ground-colour of the primaries is of a palish earthy brown with the silver markings bordered with deep maroon; the arrangement similar to that in *A. orcas*, but the short band at end of cell truncated in front and gradually narrowing backwards; no submarginal silver spots; the oblique streak towards external angle very narrow; secondaries with the ground-colour yellowish stone-colour suffused with grey (or sordid) towards base and apex; the silver markings bordered with ferruginous red; the arrangement of these markings is similar to that in *A. orcas*, but the submarginal series is placed upon a ferruginous band and is almost obliterated excepting at anal angle; the oblique internal bar above the latter is curved, so as almost to join the broad discal belt, and the two silver spots above it are greatly reduced in size; the anal lobe is much paler in colouring—ochreous with a quadrate central ferruginous patch; the fringe brown where it is black in *A. orcas*. Expanse of wings 39 mm.

Congo forest, July 16th, 1900.

I have named this beautiful little butterfly in honour of my friend Dr. W. J. Holland of Pittsburg, whose admirable photographic plate in the 'Entomological News' for 1893 has greatly facilitated the identification of the species of *Aphnæus*.

*BELENOIS CALYPSO* Drury.

Var. ♂. The secondaries white below, with the usual markings, but the orange streaks at base and apex of costa (which are usually ill-defined) and a dash at the base of the submedian vein sharply defined in deep orange (more so than in *B. dentigera*).

Prof. Aurivillius correctly states that *B. agylla* is synonymous with *B. solilucis* (not with *B. ianthe*). Until I saw the specimens in the present collection, I was not aware that the border of the primaries was ever so wide in *B. solilucis* as is shown in Rogenhofer's figure, and I naturally supposed the regularity of the border in that figure to be due to inaccurate drawing.

*BELENOIS FORMOSA* Butl.

The intermediate phase of this species from Toro differs from the wet phase in the smaller and partly obliterated white spots in the apical border of the primaries; and on the under surface in the pale earthy-brown subapical streak and veins on the primaries and the brown veins and markings on the secondaries. The dry phase (which we obtained from the Crowley collection) is still less spotted on the apical area of the primaries above, has the apical area of these wings below and the secondaries of a whitish-brownish tint with still paler brown markings than the intermediate phase.

♂, Toro (*Sir H. Johnston*); ♂ ♂, Mt. Elgon (*F. J. Jackson*).

Among the Lepidoptera Heterocera there was nothing of interest with the exception of a very remarkable new genus of *Sesiidae*, which Sir George Hampson has asked me to describe.

## CRYPTOMIMA, gen. nov.

Allied to *Ceratocorema*. Wings for the greater part opaque, brilliantly metallic: primaries narrow, elongated, the costa nearly straight to  $\frac{3}{4}$ , then gradually deflexed to apex, which is moderately acute; outer margin very oblique, slightly convex, passing gradually into inner margin, which is slightly concave almost to the base: secondaries with the costal margin nearly straight to apex, the apex moderately defined, the outer margin slightly arched to first median branch and thence nearly straight to anal angle; abdominal margin sinuous, widest in the centre. The neuration may be characterized by veins 7 & 8 of the primaries being emitted from a long footstalk; vein 4 of the secondaries absent. Body smooth and shining; the antennæ simple; palpi rather slender, elongated, second joint upturned, slightly curved, third joint porrected at an oblique angle, spine-like. Front legs with tibiæ coarsely fringed below; second pair fringed externally, the upper end of the joints with the fringe projecting, two well-developed unequal spurs; third pair smooth, with two long unequal spurs beyond the middle and two below the end of the tibiæ, the latter joints and the tarsi coarsely setose: abdomen with a long densely scaled process with naked extremity from the dorsal surface of the terminal joint, resembling the ovipositor in certain *Ichneumonidae*; vulva tufted.

## CRYPTOMIMA HAMPSONI, sp. n. (Plate I. fig. 8.)

Wings above steel-blue glossed with green, brilliantly metallic: primaries with a small bifid subbasal patch divided by the median vein; end of cell and median vein blackish blue; beyond the cell a hyaline belt brilliantly shot with golden-green from near costa to near external angle, slightly increasing in width from front to back of wing; secondaries with the basal two-sevenths hyaline crossed by steel-glossed black veins. Body above steel-black,

slightly purplish; eyes red-brown; face opaline white brown; palpi white brown, second joint with opaline white scales; pectus and legs steel-blue; terminal joints of hind tarsi whitish below; venter nacreous, the base broadly whitish followed by a still broader dull steel-blue band, beyond this a second whitish band or patch and then a second steel-blue band; anal fringes ochraceous and smoky black. Expanse of wings 35 mm.

Toro, June 16th, 1900.

I have named this remarkable insect in honour of my colleague, Sir George Hampson, Bart., who is engaged upon a complete Catalogue and Revision of the African Lepidoptera Heterocera.

#### EXPLANATION OF PLATE I.

- Fig. 1. *Acræa orinata* ♀, p. 48.  
 2. *Diestogyna amaranta* ♂, p. 47.  
 3. " " ♀, p. 47.  
 4. *Harma johnstoni* ♂, p. 47.  
 5. " " ♀, p. 47.  
 6. *Pseudathyma plutonica* ♂, p. 48.  
 7. *Aphnæus hollandi* ♂, p. 49.  
 8. *Cryptomima hampsoni* ♀, p. 50.

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February 4, 1902.

Prof. G. B. HOWES, LL.D., F.R.S., Vice-President,  
 in the Chair.

The Secretary read the following report on the additions to the Society's Menagerie during the month of January 1902:—

The registered additions to the Society's Menagerie during the month of January were 87 in number. Of these 32 were acquired by presentation and 3 by purchase, 47 were received on deposit, 4 were born in the Menagerie, and 1 was received in exchange. The total number of departures during the same period, by death and removals, was 168.

Amongst the additions attention may be specially directed to:—

1. A female White-tailed Gnu (*Connochætes gnu*), born in the Menagerie on January 10th, from one of the females presented by Mr. C. D. Rudd, F.Z.S., in August 1901.

2. Nine Pheasant-tailed Jacanas (*Hydrophasianus chirurgus*) from India, presented by Mr. Frank Finn, F.Z.S., on January 11th.

This peculiar bird is new to our collection, and we are greatly obliged to Mr. Finn for sending us the specimens, as also to Mr. Knifton, of the P. & O. s.s. 'Malta,' under whose care they were placed during the voyage home.

3. Three Red River-Hogs (*Potamochoærus penicillatus*), born in the Menagerie on January 27th.

The breeding of the Red River-Hog in captivity is a noticeable

event, but it has already occurred on two previous occasions in the Society's Menagerie (*cf.* P. Z. S. 1861, p. 62, pl. xii.).

Mr. F. E. Beddard, F.R.S., laid before the Meeting the neck-vertebræ of a young male Giraffe (*Camelopardalis giraffa*) which had died in the Society's Gardens on Jan. 8th, and made the following remarks:—

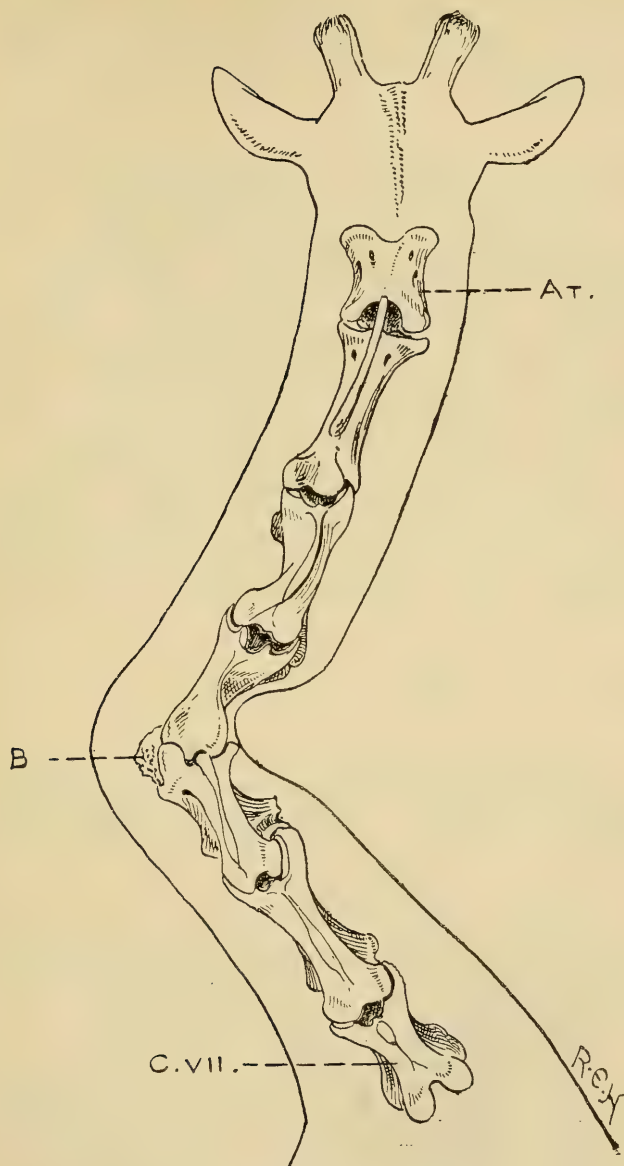
It will be remembered that this animal in life showed a permanent bend in the neck, which was slight and hardly noticeable at the time of its arrival, but increased greatly before the time of its death. After death the neck-vertebræ were carefully cleaned and have revealed the causes of this bend, which undoubtedly pressed upon the spinal cord. There was no tumour of any kind, bony or otherwise, the existence of which might possibly have been presupposed from the external appearance of the neck. The bend in the neck was in fact related to the following condition of the cervical vertebræ.

The vertebræ chiefly affected—but, as will be seen presently, not the only ones affected—are the fourth and fifth. These two vertebræ are in the first place firmly ankylosed together so as to be perfectly immovable the one upon the other. The bend occurs in this region, and is produced by these two vertebræ which lie in relation to each other at an angle of nearly 90°. This bend is due to an overgrowth on one side of these vertebræ, the left, and a cessation of growth on the other side. This overgrowth mainly concerns, so far as I can make out, the epiphyses of the vertebræ in question. The general appearance produced is that both vertebræ are shorter in relation to the adjacent vertebræ than the normal. I have observed that the fourth and fifth vertebræ are the two which have been mainly affected. Of these the fourth is more altered than the fifth. The neural spine of the fourth vertebra is curved towards the left in relation to the curvature of the whole vertebra; that is to say, the convex border of the curve is on the left side. In addition to this the spine itself is bent over to the opposite side, *i. e.* to the right, and forms a cavity deep enough to hide the first finger. Such a bending of the vertebral spine does not occur in the case of the fifth vertebra.

It is interesting to notice that the adjacent vertebræ have made an attempt, so to speak, to rectify the curvature caused by the injury to the fourth and fifth vertebræ. This state of affairs is naturally seen in the most marked degree in the two vertebræ immediately adjacent to those which have been injured. Particularly is this the case with the third vertebra. This vertebra is bent, but in the opposite direction to the fourth; it is the left side which is concave. The spine too is curved in the same direction, and there is a slight concavity formed in the same way by a bending over of the spine. This, however, lies on the left side and not on the right as is the case with the fourth vertebra. Even the axis vertebra is slightly asymmetrical, and a



Text-fig. 9.



Cervical vertebræ of a Giraffe.

Neck, showing cervical vertebræ *in situ*; dorsal aspect.

Ar., atlas; B, overgrowth of fifth vertebra; C. VII., seventh cervical vertebra.

careful examination of the posterior half of the atlas shows that it is not perfectly symmetrical. The sixth vertebra is distinctly asymmetrical, but the seventh has retained its normal symmetry.

The drawing exhibited (text-fig. 9, p. 53) illustrates the facts that have been dealt with.

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Dr. Chalmers Mitchell, F.Z.S., read, on behalf of Mr. E. Degen, a paper entitled "Ecdysis, as Morphological Evidence of the original Tetradactyle Feathering of the Bird's Fore-limb, based specially on the Perennial Moulting of *Gymnorhina tibicen*." The material on which the paper was based consisted of a large series of specimens of the *Gymnorhina* obtained at regular intervals throughout the moulting-period, and the author had thus been able to give a very complete account of the perennial replacement of the feathers, avoiding the errors due to observations on the altered habits as produced by captivity. The author showed that the moulting of the wing-feathers took place in definite groups, and indicated a composite origin of the modern feathering. He thought that the new facts brought forward strengthened his already published theory of the wing-feathers being derived from the feathers of a four-fingered manus. Incidentally he suggested that the eutaxy of the Passeres was essentially different from that of such primitive birds as the Gallinæ.

This Memoir will be published in full in the Society's 'Transactions.'

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The following papers were read :—

1. Notes on the Osteology of the Short-nosed Sperm-Whale.  
By W. BLAXLAND BENHAM, D.Sc., M.A., F.Z.S.,  
Professor of Biology in the University of Otago, New Zealand.

[Received November 8, 1901.]

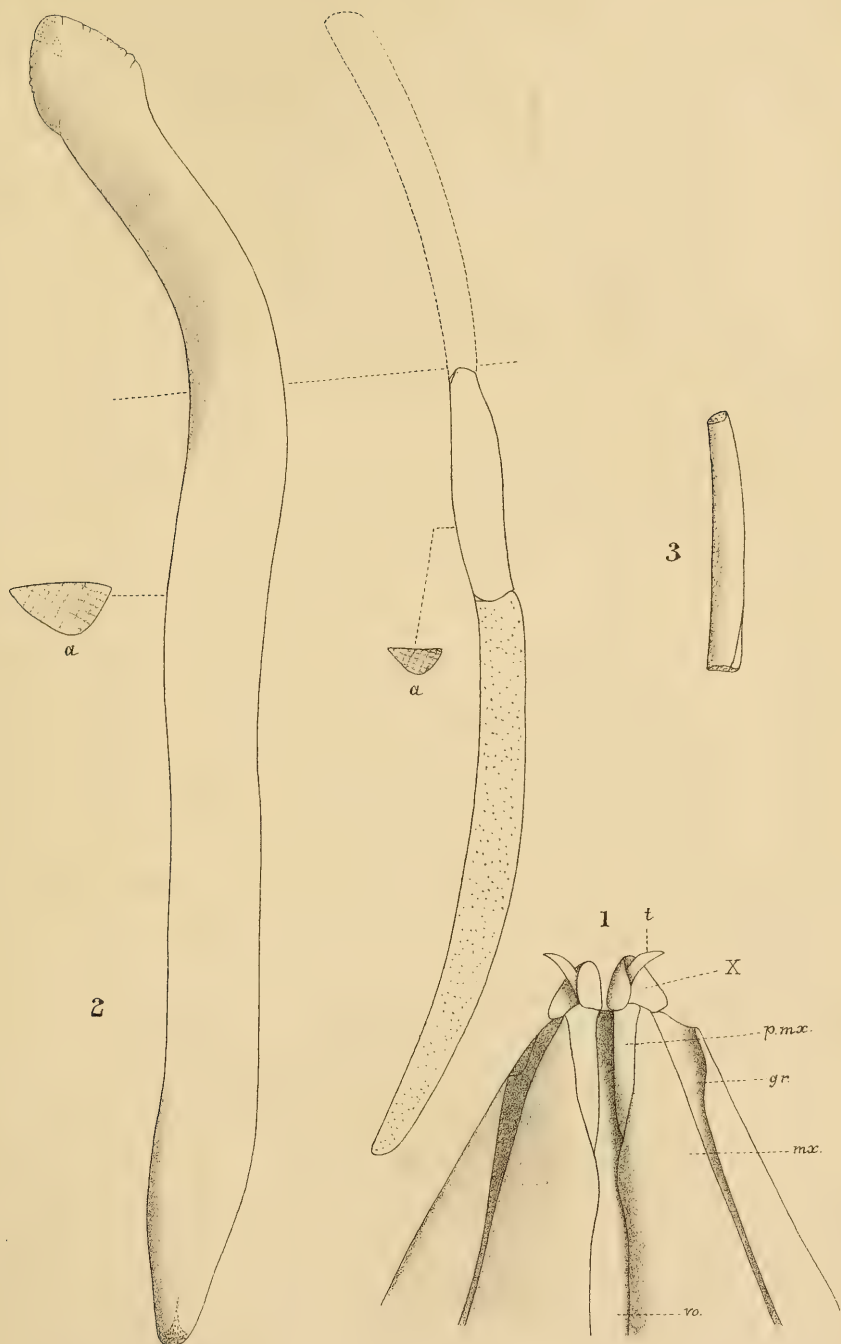
(Plates II.-IV.<sup>1</sup>)

A specimen of the Short-nosed Sperm-Whale (*Cogia brevicaeps*) came into my possession in 1900, and I have already communicated to the Society some remarks on certain of the viscera<sup>2</sup>. I now wish to offer some notes on the skeleton.

The animal, a male measuring 8 ft. 9 inches, had been cast ashore on the sandy beach at Parakanui, Otago; and though it had been a good deal cut about, I was able to obtain the entire skeleton, together with the cartilaginous portions of such structures as the hyoid, sternum, and limbs: these were put through the gelatinoglycerine process without any previous separation from the bones,

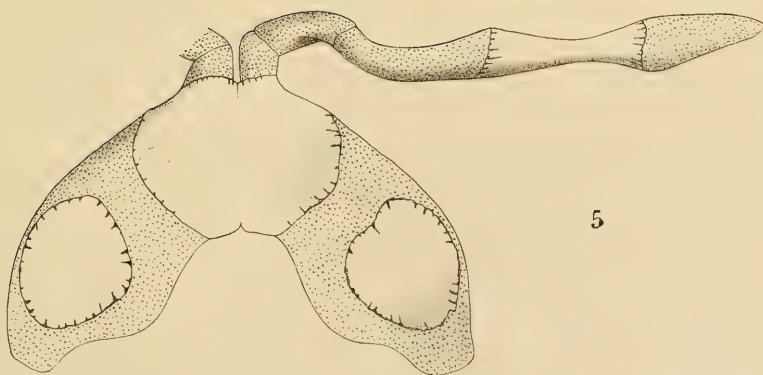
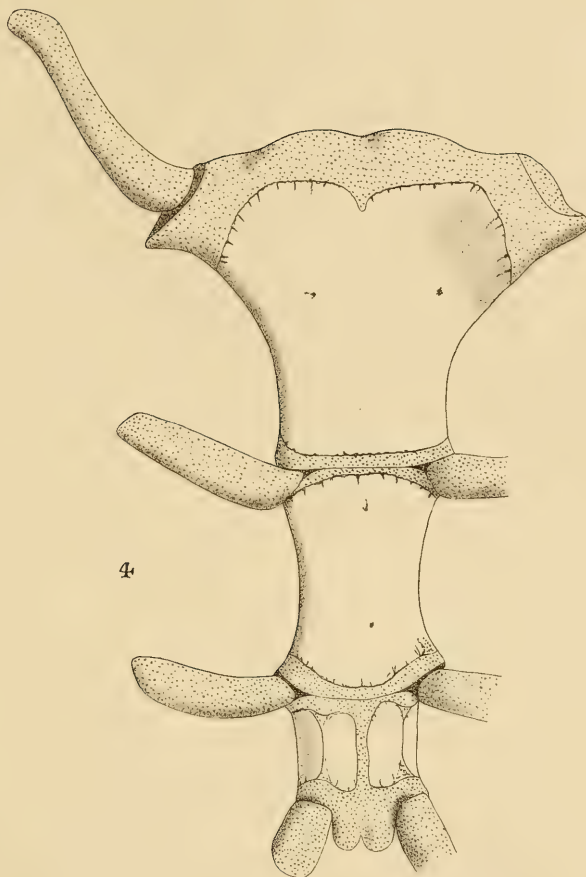
<sup>1</sup> For explanation of the Plates, see p. 62.

<sup>2</sup> See P. Z. S. 1901, vol. ii. p. 107.

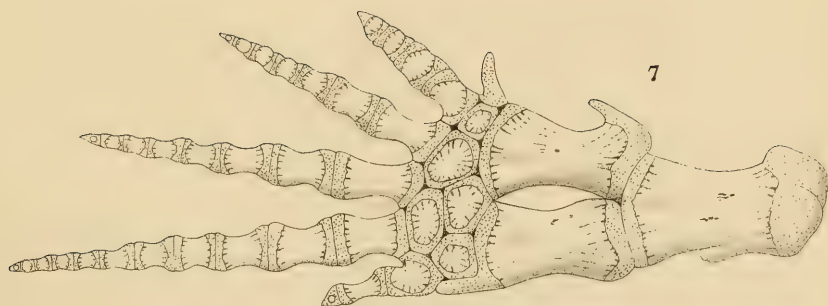
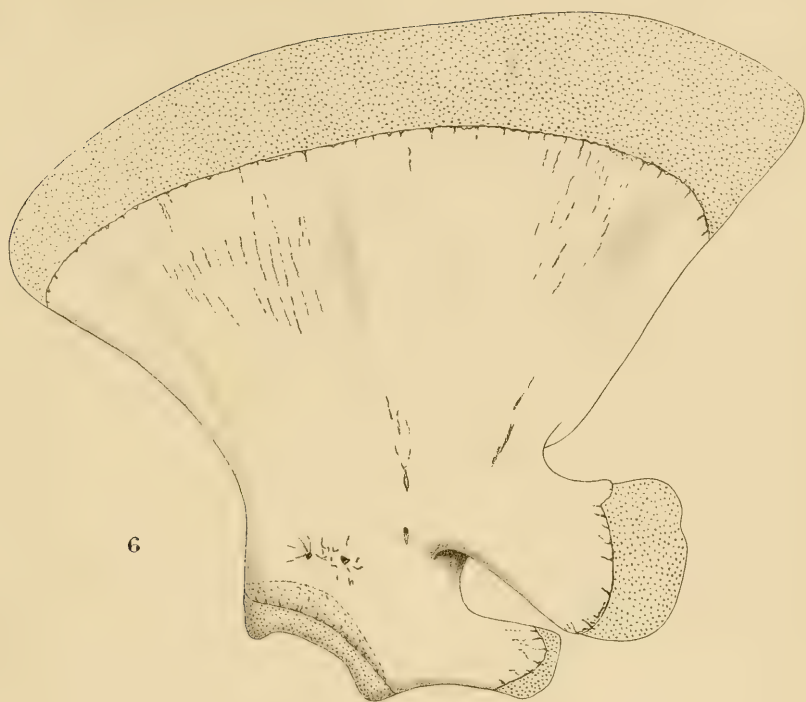














and are thus preserved in a natural condition. There is one bone upon which some doubt must still be expressed, viz. the pelvis. Wall (1) describes and figures this structure as consisting of two pairs of more or less circular or oval plate-like bones, which he arranges in a transverse row—an inner smaller and an outer larger bone on each side; the bones are very unlike the pelvic bones of other *Odontocetes*, and as they were found in the sand, it is within the bounds of possibility that the identification is incorrect.

I searched the Parakanui carcase carefully for the pelvis: I removed the penis and found no bone in connection with it, and I feel quite certain that no bone existed, for the maceration was most carefully carried out, and the contents of the macerating-tube were sifted, so that even the cartilaginous epiphyses of the larger ribs were recovered; if there had been bones of the size and shape described by Wall, they could not have been overlooked.

### *The Axial Skeleton.*

The total length of the dried skeleton, when the bones were laid out, in contact, is 2.39 metres (*i. e.* 7 ft. 11½ inches), of which the skull measures 0.39 m. (15½ inches) and the vertebral column 2.00 m. (6 ft. 8 inches). These measurements do not allow for the intervertebral discs. I have not deemed it necessary to give an account of the skull, as it has been adequately described and figured by Owen (2), and more recently by Beneden & Gervais (5). There is, however, one point to which I will refer, as it seems to have escaped the notice of previous authors.

At the tip of each premaxilla is a short triangular calcification—apparently not bone, but calcified cartilage, for it differs considerably from bone, both in colour and texture (Pl. II. fig. 1, X). Each of these “sclerites,” or premaxillary nodules as they may be termed, is grooved along its lower surface, and in this groove lay the base of the single tooth of the upper jaw. This groove is in line with that on the maxillary bone, which is continued backwards as a canal, to join the infra-orbital canal.

The premaxillary nodule is not indicated in Owen's figure, in which the upper tooth is placed in the anterior end of the maxillary groove, and not on the premaxilla at all.

I have not seen the figure given in Van Beneden & Gervais's work, but no mention of the nodule occurs in the text: indeed, these authors express some doubt as to the existence of the upper teeth (p. 349). In a second skull in the Dunedin Museum, belonging to an older specimen, obtained from Napier, in the North Island, this premaxillary nodule does not exist; nor is there any sign that it has fused with the premaxillary bone, for the form of the latter and its relations to the maxilla are precisely the same as in the Parakanui skull, if the nodule be removed. No doubt this nodule remains separable from the bone, and hence the absence of the upper teeth in most of the skulls of *Cogia*.



In the lower jaw of my specimen there are 13 teeth on each side; but in the Napier skull I find 15. The former is the number given by Wall and Krefft (3); the latter number is attributed to this whale by de Blainville and by Van Beneden & Gervais; while Flower & Lydekker, in their text-book on the Mammalia (first edition), give the number as from "9 to 12."

### *The Vertebral Column.*

Turning to the vertebral column, there are, in addition to the cervical mass of seven fused vertebræ, in which all trace of the separate vertebræ is absent, except of the 1st, 2nd, and 7th, 46 free vertebræ, of which 13 are thoracic, 9 are lumbar, 23 are caudal, of which the anterior 13 bear chevron-bones. In this enumeration I have followed Flower (on *Physeter*) in regarding as the first caudal that vertebra which carries at its hinder end the first chevron.

It may be useful to give a summary of the formula of the free vertebræ according to previous authors<sup>1</sup>.

	Total No. of free Vertebræ.	Thoracic.	Lumbar.	Caudal.	Chevrons.
Wall .....	44	14	9	21	13
Von Haast...	43	12	11	20	8
Krefft.....	48	13	9	26	10
v. Beneden } & Gervais }	?	13	8	?	?

With regard to the number of thoracic vertebræ, there thus appears from the accounts to be some slight discrepancy. Von Haast has already pointed out that the total number of vertebræ "52," given by Wall, is due to an error in addition of the constituent vertebræ. Van Beneden & Gervais state (p. 351) that "whereas Wall describes 14 thoracic vertebræ and 14 pairs of ribs<sup>2</sup>, we only count 13 on our figure." They suggest that perhaps the small 14th rib, being free and independent of the vertebral column, had disappeared during the preparation of the skeleton (*C. macleayi*), and they found only 13 thoracics in the Japanese specimens described on p. 515.

In the Parakanui skeleton there are only 12 pairs of complete ribs articulated with the vertebræ; but amongst the debris of the macerating-pan I found a small bone (Pl. II. figs. 2, 3), measuring only 37 mm. in length by 9.5 mm. in greatest breadth.

<sup>1</sup> Flower & Lydekker give C. 7; Th. 13 or 14; L.+C. 30: total 50 or 51.

<sup>2</sup> Wall found only the ribs of the right side.

The two ends are rough and evidently had cartilaginous continuations. One end is broader than the other, and is apparently the lower extremity: one surface is flat, and this I take to be the external surface; the other is very convex from side to side (see Pl. II. fig. 2, *a*), meeting the flat surface in a more or less sharp edge; one edge, the anterior, being much sharper than the other.

The general form of this little bone agrees very closely with the shape of that region of the 12th rib just distal of the curvature; here the outer surface is flat and the inner surface convex, the outline of a transverse section being (as shown in Pl. II. fig. 2, *a*) similar to that of the above small bone.

Further, I discovered a narrow, curved cartilage, four inches (100 mm.) in length, pointed at one end, truncated and slightly excavated at the broader end, which fitted on to the broad end of the small bone. There is no doubt in my mind but that this bone and cartilage constitute part, and the greater part, of the 13th rib of the left side; the upper end of which must have been connected to the 13th thoracic vertebra: the connection was probably by means of cartilage, for this narrower upper end of the bone is rough and convex.

On re-examining this vertebra, I noticed that the end of the transverse process is similar to that of the 12th, and unlike that of the succeeding vertebra, in that it has a small articular surface on the left side, but none on the right side.

We have here, I think, an explanation of the discrepancy as to the number of thoracic vertebræ; for, except in a very carefully macerated skeleton, this little bone would undoubtedly be overlooked; and in skeletons lying on the shore there is little likelihood of this last rib being found. Wall's figure, however, is erroneous in that he places the last rib (the 14th according to his enumeration) in line with the *lower* end of the preceding; but from the form of the bone and its resemblance to that part of the preceding rib, I think that it lay higher up, in the position indicated in Pl. II. fig. 2, with a long strip of cartilage below, and a shorter cartilage (which I did not succeed in recovering) above.

In Wall's specimen this last small rib measured  $1\frac{1}{2}$  inches, and the preceding rib  $11\frac{1}{2}$  inches. Krefft, too, notes that the last rib, the 13th, is but 4 inches in length, whilst the preceding is 12 inches. It is not stated whether the measurement of the rib was taken along the curve, or in a straight line from the capitulum to the free end, but presumably it was in the former manner.

In my specimen the 12th rib is 9.6 inches (235 mm.) along the outer curve, or in a straight line  $8\frac{1}{2}$  inches (215 mm.), and the bony part of the 13th rib is  $1\frac{1}{2}$  inches (37 mm.). I estimate that the total length of this rib, with both upper and lower cartilages, was about 8 inches (200 mm.).

We may then conclude that in *Cogia* there are 13 thoracic vertebræ, with 12 pairs of complete ribs articulating with the

column, and that the last (13th) rib is imperfectly ossified and that the bone does not reach up to its vertebra, except possibly in very old individuals.

### *The Sternum.*

As far as I have been able to discover, the sternum of this whale has not yet received an adequate description. It was only partially recovered by Wall, who gives but a short account of the imperfect bone, while it is not referred to either by von Haast (4) nor by Van Beneden & Gervais.

In the Parakanui specimen the sternum (Pl. III. fig. 4) consists of three sternebrae; the first and second formed of a single bone apiece, the last of a pair of small bones. Each sternebra is capped by cartilage at each end, and the posterior end is bifid.

The anterior end of the sternum is bent slightly upwards, but otherwise the bones are flat; the thickness increases from the anterior end, where it is 8 mm., to the hinder end, which is 13 mm. in depth. The first two sternebrae have rounded lateral margins, while this margin, in the case of last pair of bones, is an abrupt slope downwards and outwards from the dorsal surface, with a sharp but obtuse upper and a sharper acute lower edge—the ventral surface of this last sternebra being wider than the dorsal surface.

There are four cartilaginous sternal ribs, measuring 90, 75, 60, and 30 mm. respectively.

The following measurements were made:—

	millim.
Total length, including cartilage.....	260
Greatest breadth .....	155
Least breadth .....	45
Length of the first bony sternebra <sup>1</sup> along the lower surface .....	90
Greatest breadth .....	100
Breadth at posterior end .....	60
Thickness (dorso-ventrally) in middle.....	10
Length of second bony sternebra .....	76
Breadth at anterior end .....	54
„ in middle.....	43
„ at posterior end .....	51
Thickness .....	12
Length of each ossicle of the 3rd sternebra .....	31
Greatest breadth .....	20
Thickness .....	13

### *The Hyoid.*

The hyoid is very briefly referred to by Wall, and rather more fully described (with a figure) by Van Beneden & Gervais.

<sup>1</sup> Since the cartilages are only exceptionally preserved, the measurements of the bones are also given.

In the present specimen (see Pl. III. fig. 5) the bones and cartilage were uninjured.

The basihyal is a flat, irregularly circular bone, notched in the middle line posteriorly, and with a pair of slight prominences at the anterior end, separated only by a shallow furrow; each of these prominences bears a small tetrahedral cartilage, which evidently correspond to the bony projections seen in *Physeter*, but which in *Cogia* do not appear to ossify, for they are unrepresented in V. Beneden's figure.

The anterior cornu consists of two segments, viz.: a short proximal, curved cartilage, circular in section, representing the ceratohyal; and a much longer distal region, the middle of which ossifies to form the cylindrical stylohyal bone. The posterior cornu, as in *Physeter*, is a broad plate of cartilage, in the midst of which is a more or less circular flat bone—the thyrohyal bone. This posterior cornu is not segmented from the basihyal, the cartilage being perfectly continuous.

#### Measurements.

Basihyal bone :	millim.
Greatest breadth .....	84
„ length.....	66
Thickness .....	5
Length of cartilaginous process .....	18
Total length of each half of the basihyal + thyrohyal, from the anterior end of the cartilaginous process to tip of cornu .....	156
Greatest breadth, across the two posterior cornua, measured from the outer margins .....	188
Length of thyrohyal bone .....	55
Breadth of „ „ .....	46
Anterior cornu : total length .....	220
Length of ceratohyal cartilage (in middle line).....	37
„ stylohyal segment .....	175
„ „ bone (along its middle).....	65
„ „ hinder margin .....	75
Thickness .....	15

#### The Scapula.

This bone has been figured more or less accurately by all the authors who have dealt with this whale, but without the cartilages. The scapula has the usual cetacean form (see Pl. IV. fig. 6); its external surface is feebly concave, owing to the reversion of the anterior margin and of the superior border. The spine is but feebly developed, but the acromion is a large subquadrangular process. The coracoid process is large and well marked, not quite so long as the acromion. The glenoid cup is oval.

The following measurements of the bone, without its cartilage, were made :—



	millim.
Greatest height (from the highest point of the superior border to the anterior margin of the glenoid) .....	164
Length of the posterior border .....	107
" " anterior " .....	159
Greatest breadth (in a straight line from anterior to posterior angle of the superior border) .....	184
Breadth immediately above acromion .....	83
Length of glenoid cup .....	46
Breadth " " .....	31
Distance from the antero-superior angle to origin of acromion .....	76
Length of acromion .....	48
Vertical height (near root) of acromion.....	35
Distance from posterior margin of glenoid to tip of acromion .....	101
Length of coracoid (from anterior margin of glenoid) ..	47
Distance from posterior margin of glenoid to end of coracoid .....	84
Height of coracoid (at root).....	22

#### *The Pectoral Limb.*

The limb has been more or less imperfectly figured by the various authors—a photograph of the “restored” limb having been added to the second edition of Wall’s memoir, to replace an inaccuracy in the figure of the entire skeleton.

In this photograph, the restored carpals (which were gathered from the sand and pieced together) are fairly accurately placed; but the cartilages, having been represented by some artificial filling, do not show their characteristic independence. Wall describes “seven” carpals, but it is evident from later researches that the “two linear transverse bones” are merely the distal epiphyses of the radius and ulna, at the ends of which he locates them; the remaining 5 are accurately described in the text. The photograph is a truer representation of the hand than the woodcut accompanying Krefft’s paper.

The figure given by Van Beneden & Gervais is also incomplete. It seems therefore worth while to present a complete figure of the entire limb (Pl. IV. fig. 7) showing all the cartilages and bones in their true position.

The humerus is provided with a small deltoid ridge, 15 mm. in length and 5 mm. in height. The head and tubercle, as well as the distal epiphysis, are embedded in cartilage, but are firmly united to the shaft of the bone. But the epiphyses of the radius and ulna are not as yet united, though they can be felt at each end by a needle thrust into the cartilage.

The proximal epiphysial cartilage of the ulna is prolonged downwards as a spur, which represents the bony olecranon of *Physeter*. This cartilage is indicated in the figure given by Krefft, and in the photograph of Wall’s specimen, as a small bony process. In my specimen there is no ossification in this cartilaginous olecranon.



The distal epiphysial cartilage of the radius is produced along the outer sides of the carpus up to the metacarpal of the first digit, so as almost to suggest a carpal; but as each of the true carpals has its own cartilage around it, this prolongation seems to have some other significance.

The carpal bones are five in number, three belonging to the proximal row, and two to the distal series. Each is an irregular polygonal, more or less hexagonal, disc of bone embedded in its own cartilage. Each bone has vertical sides, without the "shelf" and without the epiphysis which exist in *Physeter*, to which, otherwise, they bear considerable resemblance. The pisiform is entirely cartilaginous. In the digits, each phalanx is provided with its own independent cartilaginous epiphysis at each end, as in *Odontocetes* generally. The metacarpals are short, not much longer than the proximal phalanx in each digit. That of the first digit is, as in *Physeter*, rounded and somewhat like a carpal; but Flower has given reasons for regarding this as a metacarpal, and the fifth metacarpal is also rounded. The relative lengths of the digits, in ascending order, are I., V., IV., III., II.

The number of phalanges is accurately shown in the drawing; whereas in the previously published figures some of the terminal, very small phalanges are missing.

The first digit possesses two phalanges;

" second	"	ten	"
" third	"	seven	"
" fourth	"	six	"
" fifth	"	three	"

These numbers refer to the right limb; on the left the second digit has only nine and the fifth only two phalanges.

It will be noted that the two to four terminal phalanges of the longer digits are more or less circular, as are all three of the fifth digit.

#### *Measurements.*

	millim.
Total length .....	372
Humerus :—Length (incl. cartilage) .....	95
"    "    shaft only .....	65
Transverse diameter of shaft at upper end .....	45
"    "    "    lower end .....	50
Girth, in its middle .....	101
Thickness .....	24
Radius :—Length along preaxial border .....	75
"    "    postaxial border .....	60
"    of bone only (in middle line) .....	60
Least breadth .....	30
"    thickness .....	12
Ulna :—Total length along postaxial border .....	63
"    "    preaxial border .....	60
"    "    of bone (middle) .....	55
Least breadth .....	26
"    thickness .....	10

	millim.
Olecranon, length .....	25
Total breadth of carpus .....	80
Digits: Total length, including cartilage:—	
Left hand: I. digit.....	52
"      II.      " .....	185
"      III.      " .....	158
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Right hand <sup>1</sup> : I.      " .....	55
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"      III.      " .....	148
"      IV.      " .....	102
"      V.      " .....	68

*List of the memoirs to which references are made.*

1. WALL: "History and Description of the Skeleton of a New Sperm-Whale." Sydney, 1851 (reprinted 1887).
2. OWEN: "On some Indian Cetacea." Trans. Zool. Soc. vi. 1865, p. 30.
3. KREFFT: "Notice of a New Species of Sperm-Whale." Proc. Zool. Soc. 1865, p. 708.
4. V. HAAST: "On the Occurrence of a New Species of *Euphysetes* on the Coast of New Zealand." Tr. N. Z. Institute, vi. 1873, p. 97.
5. VAN BENEDEN & GERVAIS: 'Ostéographie des Cétacés,' pp. 349, 515, pl. 61 (1880).

EXPLANATION OF THE PLATES.

PLATE II.

- Fig. 1. Anterior end of the ventral surface of the skull of *Cogia breviceps* ( $\times \frac{3}{4}$ ), showing the paired premaxillary nodules (*X*) carrying the teeth (*t*). *gr.*, maxillary groove. *mx.*, maxilla. *pmx.*, premaxilla. *vo.*, vomer.
2. The external surface of the last two ribs ( $\times \frac{3}{4}$ ) showing what is believed to be the true position of the rudimentary (13th) rib in relation to the 12th. The cartilaginous lower end of the rib is dotted; the upper region—indicated by dotted outline—is the presumed continuation of the rib to its articulation with the vertebra. At the side of each rib is shown the outline of its transverse section (*a*).
3. View of the anterior side of the 13th rib.  $\times 1$ .

PLATE III.

- Fig. 4. Sternum of *Cogia breviceps*, with the sternal ribs, dorsal aspect.  $\times \frac{1}{3}$ .
5. Hyoid, of which only the right anterior cornu is represented, dorsal aspect.  $\times \frac{1}{3}$ .

PLATE IV.

- Fig. 6. The right scapula, external surface.  $\times \frac{1}{3}$ .
7. The right pectoral limb, external surface. Some of the distal cartilages have been inserted from the more perfect left limb.  $\times \frac{1}{4}$ .

<sup>1</sup> Some of the terminal cartilages were imperfect on this hand, and have been restored in gelatine, but not quite accurately.





3



1



2



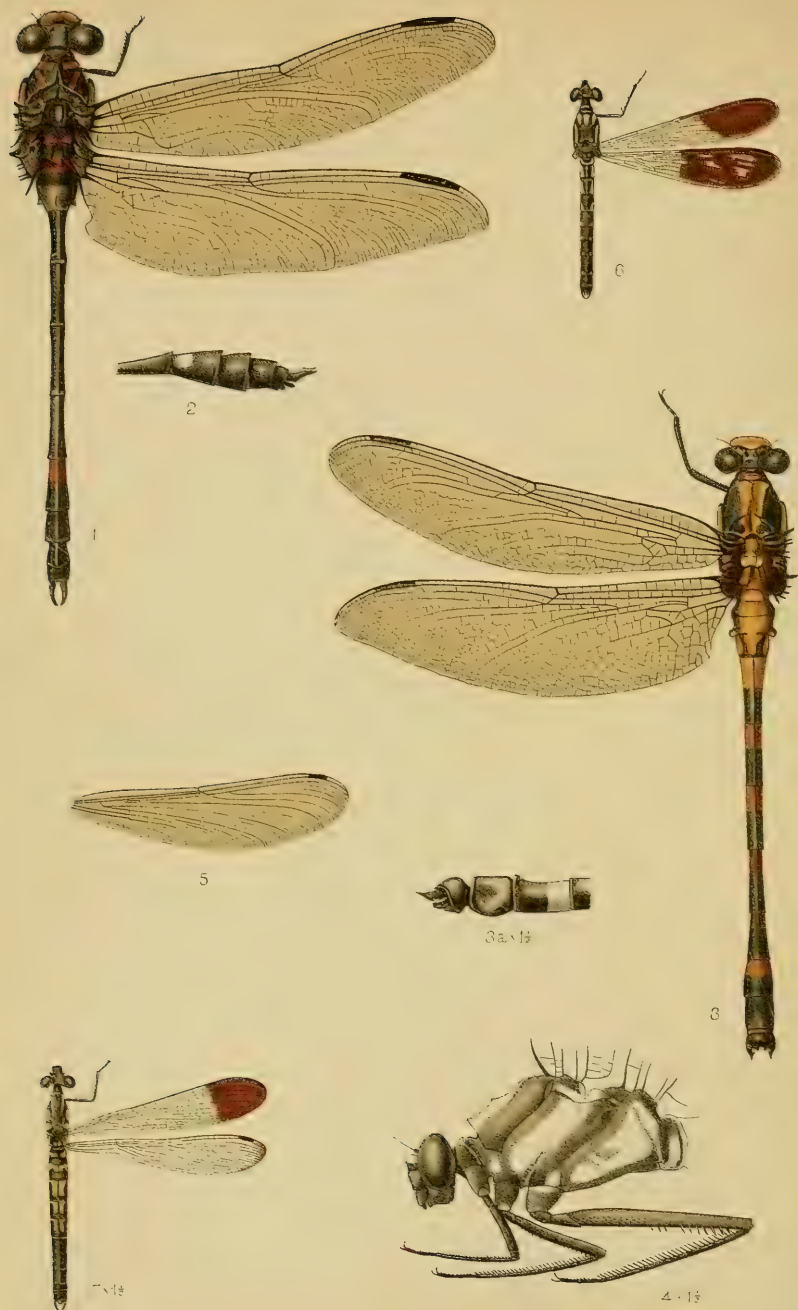
6



5







Figs 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100.

Edwin Wilson, Cambridge.

DRAGONFLIES FROM THE MALAY PENINSULA.

2. On a Collection of Dragonflies made by Members of the Skeat Expedition in the Malay Peninsula in 1899-1900.  
By F. F. LAIDLAW, B.A.

[Received December 28, 1901.]

(Plates V. & VI.<sup>1</sup> and Text-figures 10-12.)

In drawing up an account of the Dragonflies collected by members of the Skeat Expedition, I have thought it worth while to include in my list not only the names of species represented in this collection, but also of all those which I have been able to find recorded as having occurred in the Malay Peninsula. It will be seen that the list is a fairly large one, although it is impossible to suppose that the full richness of the fauna of this part of the world has been as yet revealed.

Noticeably this is the case with the *Gomphinae*; it is worthy of remark that our collection contained five specimens representing four different species, and that none of these were identical with any species previously found in the Peninsula. I have been able through the courtesy of Mr. Kirby to add to my list the names of the species taken by Mr. Ridley, specimens of which are in the British Museum. I have to thank both Mr. Kirby and Dr. Sharp very sincerely for many useful suggestions and much kind assistance.

Lastly, I have to thank the other members of the Expedition for their kind assistance in making the collection.

I have given references in every case where possible to Mr. Kirby's 'Catalogue of the Odonata,' published in 1890, where full allusion to papers published before that date will be found.

The following notes on the habits of some of the species collected may be of interest:—

**LIBELLULIDÆ.**—Almost without exception the numerous members of this family avoid forests and are to be found in flat open country, rice-fields, and clearings near the forests, especially where there happens to be a stagnant pool in the neighbourhood.

Certain very common and widely spread species are to be found wherever there is a suitable locality. Such are especially *Orthetrum sabina* and to a lesser extent *Pantala flavescens*, *Tholymis tillarga*, *Trithemis trivialis*, *Trithemis aurora*.

Certain other species with a very wide range in the Oriental Tropics seem to prefer the neighbourhood of the sea. Such are the members of the genus *Ryothemis*, also *Neurothemis tullia* and *Brachythemis contaminata*.

The rarer and more characteristic species are only to be found in up-country clearings. The only species that I saw actually in the forests were *Camacinia gigantea*, *Cratilla metallica*, *Tyrio-*

<sup>1</sup> For explanation of the Plates, see p. 92.

*bapta torrida*, *Orthetrum pruinatum*, and *Calothemis biappendiculata*. Others for the most part were caught playing round stagnant water. Rapidly running streams are invariably avoided except by *Tyriobapta torrida*.

On the other hand, the *ÆSCHNIDÆ* are mostly found in the forests, any small stagnant pool is an excellent locality; the species of *Gynacantha* and *Anax guttatus* are sometimes seen in the open. The large species of the *Gomphine* are also forest insects. Thus my specimen of *Sieboldius grandis* was taken in the same locality (a small muddy pool frequented by wild pig) with two males of *Amphibeschna ampla*; this locality also yielded *Pericnemis stictica* and *Lestes ridleyi*.

Another forest-haunting group is found amongst the *CALOPTERYGIDÆ*. *Vestalis amœna* never occurs in the open, nor over rapidly running water: probably *Echo* and *Climacobasis* have similar habits; they resemble *Vestalis amœna* so closely that they may perhaps be often mistaken for this very common species. The other *Calopterygine* are only to be found playing over rapidly running streams and rivers, and their beautiful iridescent wings add greatly to the charms of a sun-lit river-scene. *Rhinocypha fenestrella* sometimes forsakes the main stream for the shady rivulets that wander through the forest, but most of the species prefer the wider waters. The lovely *Neurobasis chinensis* wanders farther down the river perhaps than other species, but I have never seen it near the mouth of a river, or in fact after the stream had become sluggish and polluted.

Of the *Agrionine* numerous species are found in rice-swamps: few make their home in the forests, amongst these are *Pericnemis stictica* and *Lestes ridleyi* referred to above, as well as one or two species of *Psilocnemis*, *Amphilestes*, and a few of the *Protoneurous* group.

In many genera the females are exceedingly rare; this is especially the case with the *Calopterygine* genera *Euphœa* and *Dysphœa*. It has been suggested that the soberly coloured females do not attract the notice of collectors to the same extent as the males, and that hence they are rarely found in collections: but I can assert positively that in their own haunts the females are exceedingly rare; to the best of my belief, I saw only one, a female of *Euphœa ochracea*, which I secured.

### Family LIBELLULIDÆ.

#### Subfamily LIBELLULINÆ.

(Species marked with an asterisk are not represented in our Collection.)

\**ZYXOMMA PETIOLATUM* Ramb.

*Zyxomma petiolatum*, Kirby, Cat. Odonata, p. 35.

East Indies. Singapore (*Ridley*).

## THOLYMIS TILLARGA (Fabr.).

*Tholymis tillarga*, Kirby, Cat. Odonata, p. 1; Selys, Ann. Mus. Genov. (2) x. p. 439.

Common in the Eastern Tropics.

## PANTALA FLAVESCENS (Fabr.).

*Pantala flavescens*, Kirby, Cat. Odonata, p. 1; Selys, Ann. Mus. Genov. (2) x. p. 440; Ris, Arch. f. Naturg. Jahrg. 66, p. 175.

Found in the tropics of both worlds.

## CAMACINIA GIGANTEA (Brauer).

*Camacinia gigantea*, Kirby, Cat. Odonata, p. 2.

Two fine males were taken at Kwala Aring, where this species is fairly abundant near pools in open spaces. It is very difficult to catch, being a powerful flier. It haunted the same localities as *Neurothemis stigmatizans*, which resembles it very closely in colour, though of course much smaller.

## HYDROBASILEUS EXTRANEUS (Hagen).

*Hydrobasileus extraneus*, Kirby, J. Linn. Soc., Zool. xxiv. p. 547, pl. xli. fig. 1, ♀.

Recorded from Penang.

## RHYOTHEMIS PHYLLIS (Sulz.).

*Rhyothemis phyllis*, Kirby, Cat. Odonata, p. 5; id. Journ. Linn. Soc., Zool. xxiv. p. 549; Selys, Ann. Mus. Genov. (2) x. p. 443.

This species is common along the east coast of the Peninsula. Specimens were collected at Singgora, Kota Bharu, Kelantan, and at Trengganu. Occurs throughout the Malay Archipelago.

## \*RHYOTHEMIS FULGENS Selys.

*Rhyothemis fulgens*, Kirby, Cat. Odonata, p. 6.

Singapore (*Selys*); Dindings (*Ridley*). Borneo, Malay Peninsula, Sumatra.

## \*RHYOTHEMIS CURIOSA Selys.

*Rhyothemis curiosa*, Kirby, Cat. Odonata, p. 6.

Singapore (*Selys*). Sumatra. Perhaps a race of *R. fulgens* (*Selys*, Ann. Mus. Gen. xxvii. p. 451).

## \*NEUROTHEMIS FULVIA Drury.

*Neurothemis fulvia*, Kirby, Cat. Odonata, p. 7.

*Neurothemis sophronia*, Selys, Ann. Mus. Genov. xiv. (1879) p. 292.

Malacca (*Selys*). China, Bengal, Nepaul.

## NEUROTHEMIS FLUCTUANS (Fabr.).

*Neurothemis fluctuans*, Kirby, Cat. Odonata, p. 7; Selys, Ann. Proc. Zool. Soc.—1902, Vol. I, No. V.



Mus. Genov. (2) x. p. 446; Karsch, Abh. v. d. Senckenberg. nat. Gesell. xxv. 1. p. 219.

Common at Kwala Aring. Widely spread in the Eastern Tropics.

NEUROTHEMIS STIGMATIZANS (Fabr.).

*Neurothemis stigmatizans*, Kirby, Cat. Odonata, p. 7; Karsch, Abh. v. d. Senckenberg. nat. Gesell. xxv. 1. p. 218.

Plentiful at Kwala Aring. Like the last a common and variable insect.

NEUROTHEMIS DISPARILIS Kirby.

*Neurothemis disparilis*, Kirby, Cat. Odonata, p. 8.

Two specimens from Kwala Aring. Singapore (Ridley); Borneo.

NEUROTHEMIS TULLIA (Dru.).

*Neurothemis tullia*, Kirby, Cat. Odonata, p. 8; id. Journ. Linn. Soc., Zool. xxiv. p. 550.

Common near the mouth of the Kelantan River and for some thirty miles up the river. A common Eastern species.

TRITHEMIS (?) TRIVIALIS (Ramb.).

*Trithemis trivialis*, Kirby, Cat. Odonata, p. 18; id. Journ. Linn. Soc., Zool. xxiv. p. 550 (1894).

*Trithemis (?) trivialis*, Selys, Ann. Mus. Genov. (2) x. p. 467 (1891); Kirby, Ann. & Mag. Nat. Hist. (7) v. p. 531 (1900).

*Diplacodes trivialis*, Karsch, Abh. v. d. Senckenberg. nat. Gesell. xxv. 1. p. 219.

Widely distributed, ranging from India and Ceylon to Japan. I obtained specimens at Kwala Aring and Kota Bharu, Kelantan. Taken also by Mr. Ridley in Province Wellesley.

As pointed out by Mr. Kirby (Ann. & Mag. *loc. cit.*), this species probably requires the creation of a new genus to receive it.

TRITHEMIS AURORA (Burm.).

*Trithemis aurora*, Brauer, Verh. zool.-bot. Ges. Wien, xviii. p. 117 (1868); Selys, Ann. Mus. Genov. (2) x. p. 465 (1891).

*Trithemis intermedia*, Kirby, Proc. Zool. Soc. 1886, p. 327, pl. 33. fig. 4.

*Trithemis yerburii*, Kirby, Cat. Odonata, p. 18.

*Trithemis aurora*, Kirby, Journ. Linn. Soc., Zool. xxiv. p. 551.

This beautiful species was fairly common in September in marshy rice-fields at Ulu Aring. Mr. Ridley has collected it in Singapore.

BRACHYTHEMIS CONTAMINATA (Fabr.).

*Brachythemis contaminata*, Kirby, Cat. Odonata, p. 21; id.



Journ. Linn. Soc., Zool. xxiv. p. 551; Selys, Ann. Mus. Genov. (2) x. p. 468 (1891).

A widely spread Oriental species; common on the lower reaches of the Kelantan River and in the town of Trengganu.

*CROCOTHEMIS SERVILIA* (Drury).

*Crocothemis servilia*, Kirby, Cat. Odonata, p. 21; Selys, Ann. Mus. Genov. (2) x. p. 468 (1891).

Kwala Aring in August, in an open space near forest. East Indies and Australia.

*BRACHYDIPLAX MARIA* Selys.

*Brachydiplax maria*, Kirby, Cat. Odonata, p. 22.

Kwala Aring. Dindings and Selangor (Ridley). Borneo.

\**BRACHYDIPLAX MELANOPS* Selys, Ann. Mus. Genov. xxvii. p. 457.

*Brachydiplax melanops*, Kirby, Cat. Odonata, p. 22.

A small species from Selangor taken by Mr. Ridley, and now in the British Museum, probably belongs to the species indicated by de Selys, agreeing with it in its small size. Abdomen 16.5 mm. long; hind wing 22.5. The thorax and first fore segments of abdomen blue-pruinose. 6 prenodals and 5 postnodals on the fore wing. Internal triangle free.

*BRACHYDIPLAX PRUINOSA*, sp. n.

Length of abdomen 18.5 mm. Length of hind wing 24 mm.

♂. *Head* yellowish grey, margins of the upper and lower lips black, frontal tubercle, and upper surfaces metallic blue. Eyes brown.

*Prothorax* and *thorax* coppery green dusted over with very pale blue 'bloom.' *Abdomen*: first five segments grey, also coated with 'bloom,' the rest black, second and third segments with a transverse carina; legs black; pterostigma and venation black.

Fore wings: 8 antenodals, 6 or 7 postnodals. Discoidal triangle free, followed by two rows of cells.

Hind wings: 7 antenodals, 6 or 7 (usually 7) postnodals. The hind wings have a faint tint of yellow at their base.

Two males from Kwala Aring taken in August.

\**MICRODIPLAX DELICATULA* Selys.

*Microdiplax delicatula*, Kirby, Cat. Odonata, p. 22.

*MACRODIPLAX VITTATA* Kirby.

*Urothemis vittata* Kirby, Journ. Linn. Soc., Zool. xxiv. p. 552, pl. 42. fig. 2.

A male specimen from Kwala Aring. Mr. Kirby tells me that this species should be referred rather to the genus *Macrodiplax*

than to *Urothemis*. The last postnodal cell is as long or a little longer than the pterostigma in the fore wing.

**TYRIOBAPTA TORRIDA Kirby.**

*Tyriobapta torrida*, Kirby, Cat. Odonata, p. 32; Karsch, Abh. v. d. Senckenberg. nat. Gesell. xxv. 1. p. 221 (1890).

This species haunted a small forest stream close to the village of Kwala Aring. It was apparently confined to this locality in that neighbourhood. A common Bornean insect.

**CRATILLA METALLICA (Brauer).**

*Protorthemis metallica*, Kirby, Cat. Odonata, p. 30; Selys, Ann. Mus. Genov. (2) x. p. 461; Karsch, Abh. v. d. Senckenberg. nat. Gesell. xxv. 1. p. 221.

*Nesoxenia metallica*, Kirby, Cat. Odonata, p. 180.

*Cratilla metallica*, id. Ann. & Mag. Nat. Hist. (7) v. p. 542.

Common at Kwala Aring and on Gunong Inas.

**ORTHETRUM SABINA (Ill.).**

*Orthetrum sabina*, Kirby, Cat. Odonata, p. 35.

Abundant all along the East Coast. Ranges through the East Indies to Australia.

**ORTHETRUM PRUINOSUM (Burm.).**

*Orthetrum pruinatum*, Kirby, Cat. Odonata, p. 38; Ris<sup>1</sup>, Arch. f. Naturg. Jahrg. 66, p. 185, pl. ix. fig. 3.

A single specimen (♂) from Kwala Aring, September 1899. East Indies.

**ORTHETRUM TESTACEUM (Burm.).**

*Orthetrum testaceum*, Kirby, Cat. Odonata, p. 39.

A pair, *in cop.*, from Kwala Aring, September. Also a single male from the same locality. Recorded from Java.

**ORTHETRUM NICEVILLEI Kirby.**

*Orthetrum nicevillei*, Kirby, Ann. & Mag. Nat. Hist. (6) xiv. p. 112 (1894).

Described from specimens from Tenasserim. A single specimen from Ulu Aring, September 1899.

**ORTHETRUM sp.**—Our collection includes a female *Orthetrum* belonging to a species distinct from, but closely allied to, *O. sabina*. The abdomen is shorter, 26 mm., and distinctly stouter, the anal appendages are black, and the sides of the thorax are not so distinctly marked with black. I have been unable to identify it.

**LYRIOTHEMIS PRIAPEA Selys.**

*Lyriothemis priapea*, Kirby, Cat. Odonata, p. 25.

This genus is closely allied to *Orthetrum*, but differs in the

<sup>1</sup> Dr. Ris (*loc. cit.*) records *O. chrysis* from Malacca.

strongly curved sectors and in having three or four cross nervules in the submedian space of fore and hind wings.

A single specimen, a male, from Kwala Aring.

*POTAMARCHA OBSCURA* (Ramb.).

*Potamarcha obscura*, Kirby, Cat. Odonata, p. 180.

*Potamarcha congener*, Selys, Ann. Mus. Genov. (2) x. p. 459.

*Potamarcha obscura*, Karsch, Abh. v. d. Senckenberg. nat. Gesell. xxv. 1. p. 219.

This species is common at Kwala Aring, where I took two females and several males. Closely allied to *Lathrecista*, it differs in having the eighth abdominal segment in the female dilated, and the triangle of the hind wing traversed. (See also Selys, *loc. cit.*)

*LATHRECISTA TERMINALIS* Kirby.

*Lathrecista terminalis*, Kirby, Cat. Odonata, p. 30.

A single male from Kwala Aring. Recorded and described from Borneo.

\**LATHRECISTA SIMULANS* (Selys).

*Lathrecista simulans*, Kirby, Cat. Odonata, p. 30; Selys, Ann. Mus. Genov. (2) x. p. 458.

Recorded from Borneo, Sumatra, Ceylon, Malacca, and Burmah.

\**AGRIONOPTERA LINEATA* Brauer.

*Agrionoptera lineata*, Kirby, Cat. Odonata, p. 31; Selys, Ann. Mus. Genov. xix. (1879) p. 302.

Malacca. Philippines.

\**AGRIONOPTERA MALACCENSIS* Selys.

*Agrionoptera malaccensis*, Selys, Ann. Mus. Genov. xxvii. p. 461; Kirby, Cat. Odonata, p. 31.

(This genus differs from the preceding in the absence of the supernumerary antenodal nervule of the front wings, and in having several cross nervules in the submedian space, as well as in the position of the base of the triangle of the hind wings, in front of the arculus. The two genera closely resemble each other in coloration.)

\**AGRIONOPTERA NICOBARICA* Brauer.

*Agrionoptera nicobarica*, Kirby, Cat. Odonata, p. 31.  
Singapore, Nicobar Is.

\**AGRIONOPTERA SEXLINEATA* Selys.

*Agrionoptera sexlineata*, Kirby, Cat. Odonata, p. 31.  
Recorded from Malacca.

\**CALOTHEMIS BIVITTATA* (Ramb.).

*Calothemis bivittata*, Kirby, Cat. Odonata, p. 42.

*Calothemis biappendiculatus* Selys.

*Calothemis biappendiculatus*, Kirby, Cat. Odonata, p. 42.

♂. Length of abdomen 22 mm. Length of hind wing 28 mm.

Wings hyaline, slightly tinged with yellow at their bases.

Pterostigma black, 2 mm. in length, covering 3 cells.

*Fore wing.* 19 antenodals, the last continuous, 9-10 postnodals. Discoidal triangle traversed, followed by two rows of cells. 2 supra-triangular cross nervules, 2 cross nervules in the lower basal cell. Internal triangle divided into 3 cells.

*Hind wing.* 2 supra-triangular, 3 lower basal cross nervules. Discoidal triangle traversed.

*Head.* Lower lip yellow, upper lip black, eyes brown, occipital triangle black, rest of head steely-blue black except a yellow mark at the side behind each eye.

*Prothorax* black.

*Thorax* black above, dull brown below. Legs brown.

*Abdomen.* Segments 1 and 10 black, the rest bright red. Segments 2-3 with transverse carina. Segments 3-9 strongly triangular in cross section. Rising from the bases of the genital ramules are two long branches, standing at right angles to the body.

♀ unknown.

I took two specimens of this insect at Kwala Aring. They differ from the type in having the upper surface of the thorax rich black instead of brown. Otherwise they closely resemble it, especially in the very remarkable genital organs on the second abdominal segment.

\**Orchithemis pulcherrima* Brauer.

*Orchithemis pulcherrima*, Kirby, Cat. Odonata, p. 42; Karsch, Abh. v. d. Senckenberg. Nat. Gesell. xxv. 1. p. 228.

Singapore (*Ridley*). Malacca (*Selys*).

*Diplacodes nebulosa* (Fabr.).

*Diplacodes nebulosa*, Kirby, Cat. Odonata, p. 42.

A single specimen was taken at Kota Bharu, Kelantan. There are specimens in the British Museum taken by Ridley in Province Wellesley. Widely distributed in the East Indies.

*Acisoma panorpoides* Ramb.

*Acisoma panorpoides*, Kirby, Cat. Odonata, p. 43.

Kwala Aring. One specimen, ♂. Tropical regions of the Old World.

*Tetrathemis hyalinia* Kirby.

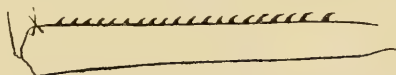
*Tetrathemis hyalinia*, Kirby, Cat. Odonata, p. 44.

The two species of this genus which are represented in our collection exhibit a very remarkable sexual dimorphism which has not, I believe, previously been remarked. The males have a

very extraordinary development of the armature of the second and third pairs of femurs. This development is paralleled in the American genus *Macrothemis* and its allies and also in the Old World genera *Schizonyx*, *Neurocena*, *Zygonyx*, and *Zygonidia*, amongst other *Libellulince* (see Calvert, Pr. Ac. Philad. 1899, p. 246).

*Tetrathemis hyalinia* has in the male, on each of the second pair of femurs, on their antero-inferior surface, 17 short straight spines directed towards the knee, increasing gradually in size, but the last three longer than the rest, more widely separated and increasing rapidly. On the antero-inferior surface of each of the third pair of femurs is a row of some 20 short curved teeth, their apices directed away from the knee, decreasing gradually in size distally; at the end of the series is a single short straight spine directed towards the knee (see text-fig. 10).

Text-fig. 10.



Third femur of *Tetrathemis hyalinia* ( $\times$  about 10).

*TETRATHEMIS PULCHRA*, sp. n. (Plate V. fig. 3.)

Length of abdomen, ♂ 16 mm., ♀ 15 mm. Length of hind wing, ♂ 17 mm., ♀ 17.5 mm.

Wings hyaline, reticulation black. Fore wings tinged with orange from the base about halfway to the nodus. Hind wings tinged with orange about as far as the nodus.

*Fore wings.* 8-9 (usually 8) antenodals, 5 (in one case on one side 6) postnodals; 1 supra-triangular cross nervule; 2 cross nervules in the lower basal cell. Triangle followed by a single row of cells.

*Hind wings.* 6 or 7 (usually 7) antenodals, 5 postnodals; no supra-triangular cross nervule; 2 cross nervules in lower basal cell.

*Coloration in the male.* Face black with yellow marks as follows: lateral lobes of lower lip, nasus, and rhinarium. The vertex and tubercle are metallic coppery black. Back of head and prothorax black.

*Thorax* black above, a few yellow spots between the wings. Sides citron-yellow with two black bands. The first of these runs from immediately in front of the first pair of wings obliquely downwards to between the second and third pair of femurs. The second runs from immediately in front of the second pair of wings down behind the third pair of femurs. The whole ventral surface is black, save that the yellow colour of the flanks extends for a short distance over the ventral surface along either side. The legs are black, inner surface of first pair of femurs citron-yellow.

*Abdomen* black, with the following yellow marks:—a spot on either side of segments 1-6, very small on 6, traversed by a black



line following the transverse carina in 3-4. On segment 7 a dorsal yellow spot divided longitudinally by the black mid-dorsal carina. Traces of a transverse carina are present on segment 5. The abdomen is slightly dilated at its base, but from segment 4 onwards very slender.

*Coloration* in the female as in the male. The traces of a transverse carina in segment 5 are more distinct laterally. The abdomen is broader and of practically equal circumference throughout.

In the male there are on the antero-inferior surface of the femur 17 short curved teeth directed towards the knee, and increasing in size distally very gradually. These are followed by three straight spines inclined in the same direction; the first of these is the shortest and the last the longest.

The third femur is provided on the antero-inferior surface with a row of 23 thorn-like teeth with their apices directed away from the knee. These increase gradually towards the distal end of the femur.

\**NANNOPHYA PYGMÆA* Ramb.

*Nannophya pygmæa*, Kirby, Cat. Odonata, p. 45.

The British Museum has a number of specimens of this species from Singapore.

#### *Genera of uncertain position.*

*NEUROCENA IDA* Hagen. (Plate V. fig. 1.)

*Zygonyx ida*, Hagen, Ver. Ges. Wien, xvii. p. 62; Brauer, op. cit. xviii. p. 370 & p. 742; Selys, Ann. Soc. Ent. Belg. xii. p. 96; id. Ann. & Mag. Nat. Hist. (4) iii. p. 274; id. C. R. Soc. Ent. Belg. xxxv. p. cxxvii.

*Pseudomacromia luxuriosa*, Karsch, Berl. ent. Zeitschr. xxxviii. p. 21.

*Zygonyx ida*, id. Ent. Nachr. xxi. p. 203; Calvert, P. Ac. Philad. 1899, p. 246.

*Neurocena ida*, Kirby, Ann. & Mag. Nat. Hist. (7) v. p. 541.

This appears to be an exceedingly variable species, and the single specimen I obtained differs to a certain extent from those described hitherto, so that it seems worth while to give a fairly full account of it.

The length of the hind wing is 42 mm., of the abdomen 38 mm.

The wings are hyaline, faintly tinged with yellow, which becomes vivid towards the outer extremities of the fore wings. In a male in the British Museum Collection the wings are almost colourless. The reticulation is black.

*Fore wings.* 14 antenodals; on the left side the outermost is continuous, on the right side discontinuous. 7 to 8 postnodals. *Internal triangle of both wings free*, discoidal triangle free. (The internal triangle is usually divided into two or three cells; de Selys states that in two females examined the discoidal triangle

is free, in three females crossed; in males it is normally free.) Two rows of post-triangular cells. Nodal sector strongly waved at its middle. Arculus at the level of the second antenodal. Two cross nervules in the submedian space.

*Hind wings.* 10-11 antenodals, 9-9 postnodals. Discoidal triangle traversed. (According to de Selys the discoidal triangle of the hind wing in the female is normally traversed; of 13 males 7 had it traversed and 6 free.) The triangle is followed by two rows of cells. The British Museum specimen (male) has but one row of post-triangular cells in the hind wings. Pterostigma in the females is about 3.75 mm. long, in the male about 2.25 mm. Sectors of triangles of hind wings widely separated at their origins.

Rhinarium and nasus livid yellow. Frons and vertex metallic blue-green. Thorax metallic blue-green. Abdomen slightly thickened at its base, metallic black with fine transverse yellow lines at the bases of segments 2 and 3 and on the transverse carinae of those segments. A yellow spot on either side of the second segment.

Legs black. In the males on each of the second pair of femurs are a number of short teeth directed towards the knee. On the third pair are 25 short teeth; of these the first eight or nine are directed towards the knee, then follow one or two not inclined, then eleven or twelve directed towards the trochanter, last one or two not inclined. In the females all the teeth on the hinder femurs are directed towards the knee.

#### ZYGONIDIA MALAYANA, sp. n.

Length of abdomen 34.5 mm. Length of hind wing 42 mm. Length of pterostigma 3.75 mm. Breadth of hind wing 13 mm.

Wings hyaline, reticulation black, pterostigma black, membranule brownish grey.

*Fore wings.* 16 antenodals, the last on the right side is discontinuous, that on the left continuous. 9 postnodals. Internal triangle divided into three cells, discoidal triangle crossed by a single nervule and followed by three rows of cells. Nodal sector waved at its middle. Two cross nervules in lower basal cells. Arculus between the level of the first and second antenodal.

*Hind wings.* 10-11 antenodals, 10-11 postnodals. Discoidal triangle traversed, followed by two rows of cells. Sectors of triangle scarcely separate at their origin. Lower basal cell with a single cross nervule.

*Head.* Labrum black, bases of the mandibles bright yellow. Rhinarium dull yellowish brown, nasus black along its ventral margin, for the rest yellow. Genæ yellow. Frons and tubercle metallic violet, but frons yellow at the sides. Tubercle truncate anteriorly, occipital triangle black.

*Prothorax* brown, posterior lobe with a rounded backwardly directed projection at the middle of its posterior margin.

*Thorax* metallic green, marked with dull yellowish brown as follows:—a fine line along the mid-dorsal carina; a lateral band

running from the second and third femora to between the wings. The whole ventral surface is yellowish brown, and this colour extends for a short distance along the humeral suture and on to the sides of the metasternum. Between the wings dorsally are three yellow spots, one behind the other.

*Abdomen* black, very slightly dilated at its base. Yellow lateral spots on segments 1, 2, 3. Base of segments 2, 3, 4 with a fine transverse yellow line; mid-dorsal carina with a scarcely perceptible yellow line from segments 3 to 7. Longitudinal yellow marks ventrally on segments 3, 4, 5 on either side of the middle line. Anal appendages black. Transverse carinae on segments 2, 3. On segment 2 there is on either side anteriorly a small tuft of fine black hairs.

*Legs* black. In the male the second pair of femurs have each a row of 18 antero-inferior short spines directed towards the knee, and increasing in size gradually from above downwards. These are followed after a short gap by three long straight spines which are also directed a little downwards (see text-fig. 11). The third pair of femurs have each 26 antero-inferior short subequal spines all directed towards the knee, save the last six, which are not inclined. Then follow two longer spines inclined towards the knee.

Text-fig. 11.



Second femur of *Zygonidia malayana*.

This species differs from *Zygonyx iris* chiefly in that the discoidal triangle of the lower wing is followed by two rows of cells, not by three; and in the absence of any dorsal markings on segment 7 of the abdomen, in the coloration of the thorax, and length of the pterostigma. It is more closely allied to *Zygonidia insignis* (Kirby, A. M. N. H. (7) v. p. 540), from which it is chiefly distinguished by its smaller size, the fewer reticulations in the postnodal spaces of the hind wings, and in the details of the spines on the second and third pairs of femurs of the male. In *Z. insignis* the second pair of femurs have each a row of 18 antero-inferior spines, followed by three much longer spines. The first 12 are directed towards the knee, the next six are not inclined, the three long spines are slightly inclined towards the knee. The third pair of femurs have each some 24 short spines, the first 14 inclined towards the knee, the last 10 scarcely inclined, followed by two longer spines inclined to the knee.

I caught two specimens of *Zygonidia malayana* at Kwala Aring in September. These, like all the other recorded specimens

belonging either to the genus *Zygonia* or to *Zygonyx*, are both males.

The character of the last antenodal cross nervule seems to be very variable. In one specimen of *Zygonyx iris* it is accidentally complete (de Selys, C. R. Soc. Ent. Belg. xxxv. p. cccxvii). In one of the two known specimens of *Zygonia insignis* it is accidentally incomplete on one side (Kirby, A. M. N. H. (7) v. p. 540). On one side of both specimens described above it is incomplete, on the other complete.

These two preceding species, together with their allies, probably constitute a separate section of the *Libellulinae* approximating somewhat closely to the *Corduliinae*. See Calvert, *loc. cit.*

ONYCHOTHEMIS TESTACEA, sp. n. (Plate V. fig. 2.)

Length of abdomen 33.5 mm. Length of hind wing 40 mm. Length of anal app. of ♂ 2.5. Breadth of hind wing 13.5 mm.

Wings hyaline, reticulation black. Pterostigma 4 mm. long.

*Fore wings.* 15 antenodals, 10–11 postnodals. Internal triangle divided into three cells. Discoidal triangle narrow, with a single cross vein, followed by three rows of cells: no supra-triangular nervule. Nodal sector waved, a single cross nervule in the lower basal space; membranule long, grey. Upper sector of triangle curved. Sectors of arcus stalked.

*Hind wings.* 9–10 antenodals, 11 postnodals. Discoidal triangle free, followed by two rows of cells. Lower basal cell with a single cross nervule. Sectors of triangle originate close together. Nodal sector waved.

*Head.* Ventral surfaces yellow, with a triangular black mark in the centre, its apex directed forwards. Upper lip black, with a reddish-brown spot on either side. Rhinarium and nasus reddish brown, with a black mark along the suture between them. Frons yellow below, steely black above. Frontal tubercle bifid, steely black. Occipital triangle black.

*Prothorax* black, with a yellow hinder margin.

*Thorax* dark metallic green, the mid-dorsal carina and a mid-dorsal line between the wings yellow. Two small orange-yellow spots on the humeral sutures on either side, the one above the other. A thin yellow band runs from immediately behind the front pair of wings downwards to between the second and third pairs of legs on either side. An orange line runs along the outer edge of the metasternum. Ventral surface black.

*Abdomen* broad, slightly dilated at its base. Segments 4 to 8 strongly triangular in section. Testaceous black with dull yellow markings. Mid-dorsal spots on the middle of segments 1 to 8. Segments 2 and 3 with a yellow-marked transverse carina; the yellow mark is discontinuous dorsally in 2, but in 3 runs into the yellow spot. Ventrally each segment from 3 to 8 has two large oblong yellowish spots on either side of the middle line. These spots extend round the lateral keel on to the sides of the abdomen and on segment 7, 8 reach to within a short distance of



the dorsal spots. Segments 9 and 10 black, segment 10 is very small. Upper appendages black, curved slightly inwards and at first downwards, but at their distal ends they turn up a little. About halfway along their ventral sides is a small tooth. Ventral appendage black, rather broad and flat, bifid at its extremity, not more than two-thirds the length of the upper pair.

*Legs* black. On each of the first pair of femurs is a single spine immediately before the knee. In the second pair on each are three long pairs of spines inclined towards the knee and distant from each other. On each of the third pair of femurs are 4 pairs of large spines, rapidly increasing distally, followed after a gap by a single pair. All inclined slightly towards the knee. On the first pair of tibiae are three pairs of long equidistant spines, on the second and third pair of tibiae are four pairs of large spines. (See text-fig. 12.)

Text-fig. 12.



Third leg of *Onychothemis testacea* ( $\times 1\frac{1}{2}$ ).

A single male from Kwala Aring.

This species differs from *Onychothemis abnormalis* (Brauer, Verh. Ges. Wien, xviii. p. 170) in having no transverse carina on the fourth abdominal segment, and in having the claws of the third pairs of legs without any sign of a tooth. I have not been able to examine a specimen of *O. abnormalis*, a Philippine Is. species, but the present species is evidently closely allied to it.

This genus appears to stand quite remote from other Libellulids, not only in the absence of a tooth on the basal claws, but in the remarkable armature of the femurs. The two species of the genus should form an independent subsection of the *Libellulinae*.

#### CORDULIINÆ.

Two members of the subfamily are known to occur in the Peninsula; these are *Macromia westwoodi*, Selys, and *Idionyx yolanda*, Selys. To these can now be added *Macromia gerstaeckeri*, recently described by Krüger from Java (Krüger, Stett. ent. Zeit. 1899, p. 335), and *Idionyx dohrni* (loc. cit. p. 326) from Sumatra.

*MACROMIA GERSTAECKERI* Krüger.

*Macromia gerstaeckeri*, Krüger, Stett. ent. Zeit. 1899, p. 335.

I caught a pair of a species of *Macromia*, which I refer to this



species, at Kwala Aring in September 1899. The male is very young.

	♂.	♀.
Length of abdomen (without appendages).	36 mm.	37.5 mm.
Hind wing .....	32	34
Pterostigma .....	2	2

♂. Antenodal nervures of fore wing 14, postnodal 7, 3. Antenodal nervures of hind wing 11, postnodal 7, 8. Supra-triangular nervures of fore wing 3 or 4, of hind wing 2. Nerves of median space of fore wing 6, of hind wing 4.

The *head* in this specimen is badly shrivelled, and it is difficult to make out the characters for the most part; the yellow 'nasus' is obvious.

*Prothorax* dull brown. *Thorax* iridescent brown, with three yellow lines on each side. The antehumeral band begins at the base of the coxæ of the first pair of legs and runs about halfway up the thorax. The middle line commences behind the middle pair of legs and runs up to behind the front pair of wings, running right across the back to join that of the other side. The hinder stripe runs along the hinder outer margin of the abdomen, starting from behind the last pair of legs. The coxæ of the first pair of legs are yellow, as also the hinder surface of those of the second and third pairs.

The *abdomen* is dull brown; segments 1-3 and 7-10 a little expanded. It has yellow markings as follows:—base of the first segment shading gradually into dull brown at its hinder end; second segment has a yellow ring covering its anterior half; third segment has two very small dorsal spots lying very close together just behind the middle of the segment; seventh segment with a transverse dorsal band taking up the anterior fifth of the segment.

Anal appendages subequal, or the inferior a very little larger than the two upper, about 3 mm. long, as long as the last two segments. The upper pair have each at about two-thirds of their length a small tooth on the outer side.

♀. *Head* and *thorax* as in the male, but the iridescent brown is replaced in the more adult female by rich metallic green. The wings have a number of vague brown marks on their outer halves.

*Abdomen.* Segments 1-6 metallic black, 7-10 dull black. Yellow markings as follows:—second segment a long spot on either side, a transverse line along its anterior margin dorsally, two small dorsal spots at about the middle of the segment; 3 with a line on either side along its lateral anterior margin not reaching the dorsal surface; 7 as in the male, but the yellow mark is broader, covering about one-fourth of the segment.

As Krüger has pointed out (*loc. cit.*), *M. gerstaeckeri* differs from its allies in its smaller size; and in the position of the small second tooth of the superior anal appendages of the male from the

other species possessing this character (*M. cincta* Rambur, *west-woodi* Selys, *borneensis*, *fumata* Krüger), in which the tooth lies at the middle of the length of the appendage.

*IDIONYX DOHRNI* Krüger. (Plate V. fig. 4.)

*Idionyx dohrni*, Krüger, Stett. ent. Zeit. 1899, p. 326.

♀. Length of abdomen 26 mm. Length of hind wing 26·5 mm.; breadth 8·5.

Triangles of all four wings undivided, those of the front wings with their anterior borders somewhat broken near their outer angle. Supra-triangular space crossed by a single nerve in all four wings. Triangles followed by a single row of cells; in the hind wings the nerve bordering the first cell of the row ends against the middle of the outer wall of the triangle, so that the second cell comes into contact with it (*cf.* characters of *I. optata* Selys, in Ann. Mus. Gen. (2) x. p. 472). On the margin of the wings this single row breaks up into 6 cells on the fore, 7 on the hind wings. The median space in the fore wing is traversed by a single nerve; hinder wing with two nerves in the median area.

Sectors of arculus with very long stalk, rising in both front and hind wings almost in the angle made by the arculus and the submedian vein. Wings tinged with brownish yellow, which is darkest at the base.

*Head* brown, with the upper lip dull yellow. Vertex metallic blue. *Thorax* brown-green, with three stripes on each side: the front one is yellow at the base of the front pair of legs, and fades into brown as it passes up along the thorax; the second and third are yellow. The abdomen is very dark brown, fading into black at the end; the ventral edge of all the segments except the first marginal with a fine yellow line, which is broadest on 2-3.

This species differs from all its congeners in having the median space of the lower wing traversed by two nerves. It is also a trifle smaller than the other species.

One female from Kwala Aring taken in September 1899.

I have given the characters of this and the preceding species rather fully because they show some points of variance with the types described by Krüger, and in the case of the first between the male and female.

### Family ÆSCHNIDÆ.

#### Subfamily ÆSCHNINÆ.

##### *ANAX GUTTATUS* (Burm.).

*Anax guttatus*, Kirby, Cat. Odonata, p. 84.

One specimen from Kwala Aring. Widely distributed in the East Indies.

##### *AMPHLESCHNA AMPLA* (Ramb.).

*Amphieschna ampla*, Kirby, Cat. Odonata, p. 93; Karsch, Ent. Nachr. xvii. (1891) no. 18, p. 10.

Two males of this species were taken at the foot of Gunong Inas. The larger specimen had its abdomen 64 mm. long, its hind wings each 62 mm. The upper pair of abdominal appendages measure 6.5 mm. This is a very handsome creature, the rich green and black thorax contrasting with the black yellow-ringed abdomen. Previously recorded from Java and Amboyna.

*TETRACANTHAGYNA PLAGIATA* (Waterh.).

*Tetracanthagyna plagiata*, Kirby, Cat. Odonata, p. 94.

*Gynacantha plagiata*, Karsch, Ent. Nachr. xvii. (1891) no. 18, p. 9.

I caught a female of this splendid species at Kwala Aring, in thick forest. It agrees very closely with the type specimen figured by Waterhouse, from Borneo (Proc. Ent. Soc. Lond. 1877, p. x; Trans. Ent. Soc. Lond. 1878, p. 119, fig. 4), but is somewhat smaller. The length of the hind wing is 69 mm., breadth 22 mm.; length of abdomen 56 mm.; breadth of head 15 mm. Recorded from Borneo and Sumatra.

My specimen has a small supernumerary spine on the right side in addition to the four normal spines on the end of the abdomen.

*GYNACANTHA ROSENBERGII* Brauer.

*Acanthagyna rosenbergii*, Kirby, Cat. Odonata, p. 95.

*Gynacantha rosenbergii*, Karsch, Ent. Nachr. xvii. (1891) no. 18, p. 9; Krüger, Stett. ent. Zeit. 1898, p. 278.

A single male and two females from Kwala Aring. Two other females probably belong to another species, but I have not been able to compare them with a series. They are from the same locality as the rest.

\**JAGORIA PÆCILOPTERA* Karsch.

*Jagoria pæcioptera*, Kirby, Cat. Odonata, p. 91; Krüger, Stett. ent. Zeit. 1898, p. 329.

Recorded by Krüger (*loc. cit.*) from Singapore.

Subfamily GOMPHINÆ.

Apparently only three species of Gomphine Dragonflies have hitherto been recorded from the Peninsula. These are:—

Legion GOMPHUS.

*Microgomphus chelifera* Selys (Mt. Ophir, Sumatra).

*Macrogomphus thoracicus* McLach. (Perak).

Legion LINDENIA.

*Ictinus melanops* Selys (Malacca).

Our collection contains five specimens referable to the following species:—

Legion GOMPHUS.

*Gomphus consobrinus* ♂ ♀, sp. n.

*Onychogomphus geometricus*, var. *nigrescens* n. (Kwala Aring, Kelantan), ♀.

Legion GOMPHOIDES.

*Sieboldius grandis* (♂, Gunong Inas, Perak).

Legion LINDENIA.

*Gomphidia perakensis*, sp. n. (♂, Gunong Inas, Perak).

#### Legion GOMPHUS.

GOMPHUS CONSOBRINUS sp. n. (Plate V. fig. 5.)

Length of abdomen 31 mm. Length of hind wing 26 mm.  
Length of pterostigma 2 mm.

*Fore wing.* No basal subcostal nervule. Sectors of the arculus distinct at their origin, then converging, meeting for a short distance, then diverging<sup>1</sup>. 11 antenodals, 10 postnodals. Pterostigma brownish black, thick. Triangles free.

*Hind wing.* 10 antenodals, 10 postnodals.

Reticulation black, membranule almost entirely absent.

General colour dull bronze-brown, lower surfaces of head and thorax greenish yellow. Dorsal surface of *thorax* dark brown, with two lighter submedian somewhat oblique bands diverging from each other from above downwards, each joining a lighter transverse antehumeral mark so as to make a 7 on either side. Sides of thorax lighter bronze.

*Abdomen* almost black, first segment greenish yellow; sides of second segment, a very fine dorsal longitudinal line on the second segment, and the auricles yellow. Segments 1, 2 somewhat dilated, 3 to 7 thin cylindrical, 8 to 10 dilated and progressively shorter.

Appendages black, upper pair of about the same length as the tenth segment, widely diverging from each other, turned up and pointed at their ends, each with a small tooth on the margin at about half its length. Lower pair diverging, rather shorter than upper pair, each terminating in a laterally directed point.

A male and a female were taken at Kwala Aring. The female had only very recently escaped from the larva and is too much withered to describe.

There seems no doubt that this is a true *Gomphus* belonging to Type A of Selys (Mon. Gomph. p. 376). The occurrence of a member of this group in such a locality is remarkable.

ONYCHOGOMPHUS GEOMETRICUS NIGRESCENS, var. n.

One ♀ from Kwala Aring, Kelantan.

Closely allied to *O. geometricus* de Haan.

Head, prothorax, and thorax as in *O. geometricus*.

Posterior surface of first pair of femurs yellow.

*Abdomen* black, marked with yellow as follows:—a dorsal band on the first and second segments, decreasing in size from before backwards, the sides of these segments are yellow. The auricles

<sup>1</sup> This feature is not shown in the figure.



are scarcely visible. Segments 3-7 have an incomplete basal orange ring, occupying in segment 3 about one-fourth of the segment, in 4-6 not more than one-sixth, and in 7 not more than two-fifths of the segment. Remaining three segments black, decreasing successively in size; anal appendages pointed, larger than the tenth segment, yellow.

Differs from the typical race in the smaller extent of the yellow marks on the abdomen. The yellow lozenge-shaped dorsal spot on segment 3 is present, that on 4 is scarcely visible. The great length of the first two cells between the sectors of the arculus is remarkable. The cross nervule enclosing the third cell is beyond the level of origin of the principal sector.

### Legion LINDENIA.

#### GOMPHIDIA PERAKENSIS, sp. n. (Plate VI. figs. 1, 2.)

Total length .....	78 mm.
Length of abdomen (without appendages) .....	54 "
Breadth of head.....	12.5 "
Length of hind wing.....	54 "
" " fore wing .....	54 "
" " pterostigma .....	8 "
Breadth of hind wing .....	14 "
Length of upper anal appendage...	4 "

Colour black with saffron-yellow markings; wings hyaline, reticulation black.

*Fore wing.* 22-23 antenodals, 17-18 postnodals. Internal triangle divided into three cells; discoidal triangle into four. Membranule small, dark brown. Pterostigma long, black.

*Hind wing.* 15-16 antenodals, 20-21 postnodals. Internal triangle divided into three cells; discoidal triangle into four.

*Head.* Labium, mandibles, and labrum black; gena black, with a dull yellow spot. Rhinarium saffron-yellow; nasus black, with a saffron-yellow spot on either side. Anterior surface of frons black, horizontal surface yellow. Vertex and occiput black. The vertex has two conical projections, one on either side as in *G. T-nigrum*, but not so large relatively. *Prothorax* black.

*Thorax* black, with the following saffron-yellow marks:—In front dorsally a semicircle broken by the mid-dorsal carina. From the outer ends of the semicircle, but separated widely from them, a short broad band runs on either side to the ante-alar sinus, inclining towards the middle lines. Behind these on either side is a small spot, just below the sinus and immediately in front of the first pair of wings. Laterally are two large bands widely separated. The first pair run obliquely forward from below the first pair of wings; the second pair are rather smaller, and run obliquely forward from below the second pair of wings: neither pair reaches the ventral surface.

Dorsally between the wings there are brown marks and a



citron-yellow spot between the first pair of wings. Ventral surfaces and legs rich black. The legs are robust, rather short; hindmost pair of femurs with stout spines.

*Abdomen* somewhat dilated at its base, then segments 3 to 6 long and cylindrical, segments 7 to 9 compressed laterally, 10 very short. Black, with yellowish marks as follows:—on segment 2 a lateral spot, the auricles, and a very small dorsal lozenge-shaped mark. Segment 3 has a trace of a yellow spot on either side and a very fine mid-dorsal line. The basal third of segment 7 with a large dorsal mark. Anal appendages black, resembling those of *G. T-nigrum* very closely.

Coloration generally remarkably similar to that of a specimen marked *Macrogomphus quadratus* in the British Museum.

A single male from forests at the foot of Gunong Inas. This fine species differs from other members of the genus *Gomphidia* in having its wings of equal length with the abdomen. It appears, moreover, to be the largest known member of the legion *Lindenia*. The internal nervule of the pterostigma can hardly be said to be prolonged, but this character is scarcely of sufficient importance to justify the removal of this species from the genus *Gomphidia*. The form of the anal appendages and the absence of any leaf-like dilatation of the sides of segments 7 or 8, as well as the shape of the vertex, indicate that it must be referred to this genus, of which it may form a new section.

#### Legion GOMPHOIDES.

SIEBOLDIUS GRANDIS Krüger. (Plate VI. figs. 3, 3a, 4.)

*Sieboldius grandis*, Krüger, Stett. ent. Zeit. 1898, p. 311.

I refer to Krüger's species a fine male, which agrees in size, wing-characters, and coloration fairly closely with the females described by him from Sumatra.

Total length .....	83 mm.
Length of abdomen (without appendages) .....	59 "
Length of appendages (upper pair) .....	2 "
Fore wing, length .....	55 "
"    breadth .....	12 "
Hind wing, length.....	52 "
"    breadth .....	15 "
Pterostigma .....	5.5 "
Femur of last pair of legs.....	20 "
Tibia " " .....	14 "
Breadth of head.....	11 "

Antenodal cells of fore wing 22–23, postnodal 18–19; of hind wing 16–17 and 17 respectively. Pterostigma lies over six cells. Basal subcostal nerve present in all wings. Triangles of all four wings with one cross nervure. The middle thirds of all the wings

have, when looked at obliquely, a very faint whitish "smoky" appearance.

*Head* small, black save for a yellow transverse band on the 'frons' before the eyes, stopping abruptly at its anterior edge. Eyes distant. Occiput with the two convexities at its hinder margin more pronounced than in *S. japonicus*.

*Prothorax* black; at its hinder margin a transverse yellow band tapering laterally. In front of this is a yellow spot.

The colouring of the *thorax* is just as described by Krüger for the female. On the upperside a yellow band runs from the front margin up to the yellow marking in between the wings; this band is twice as broad in front end as it is at its hinder end. On either side are two fairly broad yellow oblique bands.

The *abdomen* is ringed with black and yellow; the first segment is yellow with a black mark on either side. These black marks are continued on to the second segment, in which they run a little obliquely up to the dorsal surface, meeting at the hinder end of the segment; a fine black ring runs round its posterior margin. This segment is black below, and the auricles are tipped with black continuous with the lateral stripes. The yellow ring of segments 3-8 occupies the following portion of each segment: the front two-fifths of 3, the front one-third of 4, 5, one-fourth of 6, 7, two-fifths of 8; 9 and 10 are entirely black. There is a very fine mid-dorsal black line in 3; this is present, increasing in breadth as one passes back from 4-7, but absent in 8. The appendages of the tenth segment agree very closely with those figured by de Selys for *S. japonicus* (Selys, Mon. Gomph. pl. xiii. fig. 3 b). The upper pair are rather shorter than the tenth segment, slightly ciliated except at their end, which is sharply pointed and curved upwards; they carry two teeth on their lower side, one at about a third of their length rather blunt, directed downwards and a little outwards, the other at the end of the second third, sharper and curved backwards. The lower pair about half the length of the upper pair, thick and blunt.

The femurs of each leg have a number of short prickly spines on their outer lateral face; the hinder pair have a few delicate hairs on their upper surface. All have short tooth-like spines in regular rows along their lower sides.

A single specimen (♂) was caught at the foot of Gunong Inas (about 1000 feet above sea-level) near a small jungle-pool, in January 1900.

### Family CALOPTERYGIDÆ.

#### Subfamily CALOPTERYGINÆ.

The following is a list of the Calopterygines mentioned in Kirby's Catalogue or elsewhere as known to occur in the Malay Peninsula up to 1890:—

*Neurobasis chinensis* Linn.

*Vestalis amœna* Hagen.

- Euphæa impar* Selys.  
 „ *ochracea* Selys.  
*Dysphæa limbata* Selys.  
*Devadetta argyroides* Selys.  
*Rhinocypha fenestrella* Selys.  
 „ *biforata* Selys.  
 „ *petiolata* Selys.  
*Micromerus aurantiacus* Selys.  
 „ *stigmatizans* Selys.  
 „ *hyalinus* Selys.

Since that date Dohrn has added the following to the list:—

- Micromerus lineatus* Selys.  
 „ *signatus* Krüger.

Our collection contains examples of the species enumerated below:—

- \**Echo modesta* ♀, sp. n.  
 \**Climacobasis lugens* ♂, sp. n.  
*Neurobasis chinensis* ♂ ♀.  
*Vestalis amœna* ♂ ♀.  
*Euphæa impar* ♂.  
 „ *ochracea* ♂ ♀.  
*Dysphæa limbata* ♂.  
*Rhinocypha fenestrella* ♂ ♀.  
 „ *biforata* ♂ ♀.  
 \* „ *inas* ♂ ♀, sp. n.  
 \* „ *karschi* ♂.  
 \**Micromerus affinis* ♂ ♀, sp. n.

[Species marked \* are new to the Peninsula.]

#### Legion CALOPTERYX.

ECHO MODESTA, sp. n. (Plate V. fig. 6.)

1 ♀, Kwala Aring.

Abdomen, length 41 mm. Hind wing, length 37·5 mm.

Fore wing with 33–36 antenodals, circ. 45 postnodals: hind wing, 32 antenodals and circ. 40 postnodals. Basal area with 9–10 cross nerves in fore wing, 8–9 in hind wing. Quadrilateral with 9–10 cross nerves in fore wing, 7 in hind wing.

Head. Mouth-parts black; antennæ black, second joint long and thick, third joint longer but much thinner. Rhinarium black, nasus bright metallic green, rest of the head very dark bronze-green.

Prothorax dark bronze-green. Thorax the same colour, rather brighter at the sides; underparts brown; legs of the same colour, but the femurs have some irregular black marks on their upper sides; hairs very long and numerous.

Wings hyaline, with a faint brownish tinge at their outer extremities. Pterostigma rather longer than broad, pale brown,

lying over 4-6 cells. Behind the pterostigma are first two rows of cells, then, after about five cells, only one row.

*Abdomen* dark brown, with a green iridescence in some lights on the first three and last three segments. Tenth segment very short, not half as long as the ninth, ninth longer than the eighth. Appendages shorter than the tenth, black, conical, and sharply pointed.

This species differs from *E. uniformis* Selys (? = *E. tricolor* Krüger) in having a smaller number of postnodal cells (it possesses 45 as against 60-65), in its rather smaller size, and in the colouring of the wings, which are described by Krüger as being in the female yellow all over, especially at the base and anterior margin, whereas in *E. modesta* the base of the wings is perfectly transparent (Krüger, Stett. ent. Zeit. 1893, p. 72; Selys, Bull. Ac. Belg. (2) xlvii. p. 357, id. Ann. Soc. Ent. Belg.).

There is a female in the British Museum from Mr. Ridley, collected in Penang, belonging to this species. It has 37 antenodals and 48 postnodals in the fore wings. Its abdomen is of a dull dark red-brown colour.

#### CLIMACOBASIS, gen. nov.

Basal area of wings reticulated. Pterostigma long; quadrilateral long, rectangular; arculus bent, sectors starting at the same point just below its middle. Principal and subnodal sectors rise at about the same level from the reticulum, between the upper sector of the arculus and the median nerve.

The nervule closing the lower basal cell runs from the lower sector of the arculus straight down to the lower extremity of the lower basal cell.

#### CLIMACOBASIS LUGENS, sp. n. (Plate VI. fig. 5.)

(Last three segments of the abdomen missing.)

Length of abdomen (segments 1-7) 42 mm. Length of hind wing 47 mm. Breadth of hind wing 10 mm.

Fore wing with 37 antenodals, 45 postnodal nerves. Pterostigma covering 8-9 cells, about 2.5 mm. in length, very black. Basal area with 8 cross nerves.

*Hind wing.* 34 antenodals, 37 postnodals. Pterostigma as in fore wing, basal area with 8 cross nerves.

*Head.* Lower lip, base of the mandibles, and upper lip black. Between the eyes, running forward as far as the epistome, is a remarkable square milky-white patch of considerable size, taking up in fact the greater part of the vertex. Along its hinder margin it is notched in the middle by the anterior ocellus, which is surrounded by a very small black ring which is continuous with a rectangular black patch, in which lie the two posterior ocelli; the rest of the head is of a very dark bronze-green colour.

*Prothorax* dark green, almost black.

*Thorax.* Dark metallic green above, with all the sutures and

the interalar space black; under surface and legs sooty black with long hairs. Wings hyaline. Legs brownish black, with very long hairs.

*Abdomen* (first 7 segments only) dull brownish black.

There can be, I think, no doubt that this species has as its nearest known ally *Archineura*. I believe, however, the differences between them are of generic rank, the chief of these being the much smaller number of accessory nervures running to the hinder margin of the wings, the mode of origin of the principal and subnodal sectors, and the character of the nerve running to the lower basal cell.

The only specimen taken has unfortunately been rather badly knocked about and has lost the last segments of the abdomen. It was caught in September in jungle at Kwala Aring. Its habits were similar to those of *Vestalis amena*, for which at first I mistook it.

Foerster, in discussing the affinities of the genus *Matronoides*, has proposed the following arrangement of the genera belonging to the legion *Calopteryx* (Foerster, Ann. Soc. Ent. Belg. p. 66, 1899):—

Basilar space free.....	{	No pterostigma .....	{	<i>Sylphis.</i> <i>Calopteryx.</i> <i>Phaon.</i> <i>Vestalis.</i>	
		Pterostigma present ...	{	<i>Umma.</i> <i>Sapho.</i> <i>Mnais.</i> <i>Psolodesmus.</i>	
Basilar space with cross nervules.	{	No pterostigma .....	<i>Neurobasis.</i>	{	<i>Matrona.</i> <i>Matronoides.</i> <i>Neurobasis.</i>
		A pterostigma present.	{	<i>Echo.</i> <i>Archineura.</i>	

If this grouping be accepted, and it is very convenient, the last division may now stand as follows:—

Pterostigma present.	{	Short rhomboidal pterostigma...	<i>Echo.</i>
		Pterostigma at least three times as long as broad.	{ <i>Archineura.</i> <i>Climacobasis.</i>

#### NEUROBASIS CHINENSIS (Linn.).

*Neurobasis chinensis*, Kirby, Cat. Odonata, p. 102; Selys, Odon. de Sumatra, Ann. Mus. Genova (2) vii. p. 189; Selys, Odon. de Birmanie, loc. cit. (2) x. 1890-1, p. 487; Selys, *Neurobasis chinensis* et ses races locales, Ann. Soc. Ent. Belg. 1896; Karsch, Ent. Nachr. xvii. no. 16, p. 243.

Five males, three females, from the Aring River in Kelantan.

This species appears to travel further down the rivers than any other *Calopterygine*, at least so far as my observations went. It is very widely spread in Tropical Asia.



VESTALIS AMÆNA Hagen.

*Vestalis amæna*, Kirby, Cat. Odonata, p. 103; Karsch, Ent. Nachr. xvii. 1891, no. 16, p. 242; Krüger, Stett. ent. Zeit. 1898, p. 75.

Several males and females from Kwala Aring and from the foot of Gunong Inas.

This species occurs also in Borneo, Java, and Sumatra.

*Note*.—Two females from Kwala Aring differ rather markedly from the rest of our specimens. The general colour of the body is dark bronze-green rather than emerald-green of the other specimens. Further, the wings have a distinct brownish tinge. In respect to the markings on the head, the yellow is brighter than in the other specimen. One male shows a tendency to have the wings tinged and is also of a more bronze-green shade than the other males. These three specimens are perhaps much more adult than the others.

Legion EUPHÆA.

Genus EUPHÆA Ramb.

*Euphæa* Ramb. Ins. Névr. p. 228 (1842); Selys, Syn. Cat., Bull. Ac. Belg. 1853, p. 50; id. Mon. Cal., l. c. 1854, p. 167.

*Pseudophæa* Kirby, Cat. Odonata, p. 109.

*Euphæa* Selys, Ann. Soc. Ent. Belg. p. 338 (1891).

EUPHÆA IMPAR Selys.

*Pseudophæa impar*, Kirby, Cat. Odonata, p. 109.

Four males from the Aring River above Kwala Aring.

This species differs greatly from the following, not merely in the colouring of the wing but also in the wings being much broader proportionately and with very rounded tips.

EUPHÆA OCHRACEA Selys.

*Pseudophæa ochracea*, Kirby, Cat. Odonata, p. 109.

*Euphæa ochracea*, Selys, Ann. Mus. Genova, (2) x. p. 489.

Four ♂, one ♀: two males from the Aring River in Kelantan, the other three individuals from the Selama River at the foot of Gunong Inas.

The male is a very beautiful insect, and when alive his wings seem to be almost crimson in colour as he hovers over the surface of the stream. The wings of the female specimen have hardly a trace of yellow tinge (*cf.* Selys, *loc. cit.*), and the pterostigma is brown, those of the wings of the male being rich velvety black. The rich red markings of the thorax of the male are dull brown in the female, and the whole body is duller.

Length of abdomen without	♂.	♀.
appendages .....	36 mm.	30 mm.
Length of hind wing .....	29 "	29 "
" fore wing .....	31 "	30.5 "

Known also from Burmah and Borneo.

*DYSPHÆA LIMBATA* Selys.

*Dysphæa limbata*, Kirby, Cat. Odonata, p. 110.

Seven males from the Aring River some way above Kwala Aring. Known also from Borneo.

This species is regarded by Selys as a local race of *D. dimidiata* Selys, described from Borneo. In all my specimens the black mark at the base of the fore wing extends just beyond the level of the nodus and its margin is straight, at right angles to the anterior margin of the wing. On the hinder wing the black basal mark reaches halfway between the nodus and pterostigma and its outer margin slopes inwards a little.

Selys has remarked on the scarcity of the females of this group (Bull. Ac. Belg. (2) xxxv. p. 487). From my own experience I am sure that this scarcity in collections is not due to their being overlooked by collectors. I can safely say that I never saw a female of this species or of *Euphæa impar*, whilst the males were at times abundant.

## Legion LIBELLAGO.

*RHINOCYPHA FENESTRELLA* Ramb.

*Rhinocypha fenestrella*, Kirby, Cat. Odonata, p. 113; Selys, Ann. Mus. Genov. (2) p. 491 (1891).

This species, which is closely allied to *R. quadrimaculata* of India and *R. spuria* of the Khasia Hills, ranges from Burmah as far south as Penang. It is fairly common on the Kelantan River, and Mr. Evans took some specimens in Patalung. There are two specimens in the British Museum from Province Wellesley, taken by Mr. Ridley.

*RHINOCYPHA BIFORATA* Selys.

*Rhinocypha biforata*, Kirby, Cat. Odonata, p. 113.

This species occurs rather more abundantly than the last on the Kelantan River. I also found it fairly common near the foot of Gunong Inas.

*RHINOCYPHA INAS*, sp. n. (Plate VI. fig. 6.)

Length of abdomen ♂ 19 mm. Length of hind wing ♂ 23 mm.  
Length of abdomen ♀ 18 mm. Length of hind wing ♀ 24 mm.

♂. Black. *Head* with five yellow spots, two in front on either side of the ocelli, three in a transverse row behind these, the median spot transversely elongated.

*Prothorax* with two small anterior and two larger lateral blue marks. Posterior lobe orange with black margin.

*Thorax* with a short blue mesothoracic triangle rose-colour, on either side of this lies a blue triangular humeral mark not extending higher than the apex of the mesothoracic triangle. Sides of thorax blue with two black marks on either side, the anterior running from below the first pair of wings does not extend all the way down to the legs. The second stripe, which is

broader above, runs from below the hinder pair of wings to behind the third pair of legs. The blue sides are margined postero-ventrally with a black line. Lower surface black, with two broad blue marks behind the legs.

*Abdomen* black. Segments 1-9 with triangular blue spots on either side, their bases resting on the hinder margin of each segment. Those in 2-3 extend the whole length of their segments, that in 4 for half the length of that segment, the rest are small.

*Anal appendages* black. Legs black. The two hinder pairs of femurs and tibiae are white on their inner surface.

*Wings* tinged with yellow, blackish in the costal area from the fifth postnodal cross nerve; from about three-fifths the distance between the nodus and the black pterostigma the apical portion of the fore wing is purplish brown to the tip, except along its lower margin, where it is dusky grey shot with iridescent green. The purple mark commences suddenly and its inner margin slopes outwards from in front.

The outer half of the lower wing is also marked with brownish purple, the extreme apex and the posterior margin excepted, these are greyish brown. The inner border of the purple mark is straight, and the mark is crossed by two rows of iridescent hyaline spots. The inner row consists of three spots. The upper of these, consisting of one row of cells, lies above the nodal sector; the second, consisting first of one and later of two rows, lies between the subnodal and median sector; and the third, above the upper sector of the triangle, consists of a single row of cells. The upper spot is nearest to the base of the wings, the lowest is furthest from the base.

The first row lies at a level of about half of the distance between the nodus and pterostigma. The second row consists also of three spots. The upper is the largest and its distal end just overlaps the pterostigma. It consists of two, followed by three or four rows of cells, and is placed in series with the upper spot of the first row. The lowest spot of the outer series is placed serially with the middle spot of the inner series, whilst the middle spot of the outer series, consisting of a single row of cells, lies between the two others.

There is also a hyaline spot just at the middle of the hind wing consisting of a single row of cells, this impinges on the inner margin of the brown spot.

♀. *Head* as in the male, with the following additional marks yellow:—four spots on the dorsal surface of the 'snout' and the second joint of the antennæ, the upper half of the epistome. The genæ are marked with greenish blue in the male and yellow in the female. Prothorax black, with lateral yellow and a fine mid-dorsal yellow spot.

*Thorax* black, mesothoracic carina orange; a fine orange line running to the base of the first pair of wings between the carina and the humeral suture on either side, this latter is also yellow;

under surface yellow, the yellow extends for a short way on to the sides. *Abdomen* black, mid-dorsal carina orange, a yellow spot on either side of first segment. Segments 2-4 have on either side a yellow line followed by a yellow dot. Wings hyaline.

Antenodals 11-14.

This species is closely allied to *R. perforata*, but differs from that species and its other allies in the greater extent of the purple mark on the fore wings of the male. The marks of the hind wing resemble most closely those of *R. whiteheadi* Kirby.

Seven males, four females, Gunong Inas.

*RHINOCYPHA KARSCHI* Krüger, Stett. ent. Zeit. 1898, p. 33.

Three males from the Aring River near Kwala Aring.

Abdomen, length without appendages ..... 14·15 mm.

Hind wings ..... 20 „

A single row of postcostal cells. Fore wings yellowish hyaline, hind wings with a blackish-brown mark covering their outer extremities starting about halfway between the nodus and pterostigma, its inner margin convex. No vitreous spots on the wings. The abdomen has on its dorsal side a brick-red spot on segments 2-6; that on segment 2 is small and oval, from 3-6 the spots are large and rectangular, the sides of the rectangle are longer than the ends. On segment 7 are two long red lines divided by a fine mid-dorsal black line, and on segment 8 two very small red spots similarly divided. In one case the spot on segment 6 is also divided by a black line. The sides of segments 1-8 have each a yellow comma-shaped mark.

Krüger points out that this species belongs to a group intermediate in character between *R. heterostigma* and *R. tincta* of de Selys. Described by Krüger from specimens from Sumatra.

*MICROMERUS AFFINIS*, sp. n. (Plate VI. fig. 7.)

Two males, one female, Kwala Aring.

♂. *Head* black, rhinarium dark metallic blue. A small reddish-yellow spot on either side of the ocelli, behind these three others of the same colour, viz. a transversely elongated median spot on the top of the occiput and two lateral spots.

*Prothorax* black, with two small lateral spots, two anterior dorsal spots, and a single posterior dorsal spot of the same yellow colour as the head-spots. There is also a fine yellow line running along the dorsal posterior margin, ending laterally in a spot of the same colour just above the base of the first pair of legs.

*Thorax* black, a small antehumeral stripe on either side not reaching to the top of the mesothorax, and a fine line on the upper half of the humeral suture also yellow. At the sides are two large oblique yellow bars; the anterior of these is divided into two halves by a black mark projecting into it from its hinder



margin. In the upper half is a large black spot, and at the bottom of the lower half is a smaller spot also black.

*Wings* hyaline. Outer two-sevenths of fore wings (which are without pterostigma) opaque dark brown. Five antenodals (six in one case). Lower wings with a slight brownish opacity at the margin. Postnodals 11-13.

Length of hind wing 17 mm.

*Abdomen* black, with the following yellow marks:—On segments 2-6 a dorsal spot divided longitudinally into two by the mid-dorsal black carina. On segments 4-5 these marks have an anterior lateral prolongation, giving them the appearance of two figure 7's lying back to back; in segment 6 the lower limb of the 7, so to speak, has disappeared, leaving merely two anterior marginal lines. A large lateral spot on segment 1. On either side of segments 2-3 are two spots in the form of a '!', the 'dash' being anterior. On 4-5 only the 'dash' is present and is very small on 5. Anal appendages black, upper pair two-thirds length of the 9th segment.

♀. *Head* as in the male, with black less velvety, yellow marks lighter, and the following additional yellow markings:—Basal parts of lower lip and of labrum, epistome with a yellow spot on either side. Frons with four spots arranged in the form of a square, the anterior pair larger than the posterior. Genal region yellow.

*Prothorax* and *thorax* as in the male, but the thorax has a median dorsal yellow stripe. *Abdomen* dull black, with a fine mid-dorsal yellowish line on each segment, not continuous at the margins from segments 2-9. In 9 it occupies only the posterior half of the segment. Segments 1-9 each with a conspicuous lateral yellow mark running nearly the whole length of the segment, narrowest at the middle except in 9, where it is reduced to a spot at the hind end of the segment, which is larger than the eighth, as large as the seventh. Tenth very small. Length of abdomen 13 mm.

*Wings* hyaline, pterostigmata pale brown. Length of hind wing 19 mm.

Differs from *M. semiopacus* in having the apex of the hinder wing opaque, in the possession of markings on the head, and in the spots on segment 6 of the abdomen. The brown mark of the front wings is also rather less extensive,  $5\frac{1}{4}$  mm.; 6 in *M. semiopacus*. From *M. martinae* Karsch it differs in having only three yellow spots at the back of the head, in the markings at the sides of the thorax, and in having the dorsal abdominal markings broader in front; also in the rather smaller number of antenodal nerves on the fore wing.

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*Description of a new Species of the Genus Lestes.*

LESTES RIDLEYI, sp. n.

♂. Length of abdomen (without appendages) 48 mm., of hind wing 31 mm., pterostigma 2.75 to 3 mm.

General colour dull bronze-green. *Wings* hyaline, iridescent, slightly tinged with brown at the tip. Two supplementary sectors between the subnodal and median sector, 18-19 post-nodals. The nodal sector begins in the seventh cell after the nodus in the fore wings, and in the sixth in the hind wings. Reticulation and pterostigma black.

*Head.* Lower lip dull yellowish brown, upper lip brown, rest of the upper part of the head bronze-coloured.

*Prothorax* dull brown, with a small bronze transverse mark along its posterior margin, which is not indented.

*Thorax.* Upper surface dark bronze-green, with an obscure paler line following the humeral suture. Sides and lower surface yellowish brown.

*Abdomen.* First segment yellowish brown. The segments 2-7 have a roughened dorsal surface, which is brown-green with a fine yellowish-green basal ring; ventral surface bluish green, the bronze extends laterally; segments 8-10 smooth, bluish, pruinose. Anal appendages lost, but, if I remember rightly, these were also of a bluish colour.

The male was taken in the same locality as the specimen of *Pericnemis*, at the foot of Gunong Inas. There is stated to be a female belonging to the same species, which I have not examined, in the British Museum collection, taken by Mr. Ridley in Singapore.

*L. ridleyi* is closely allied to *L. orientalis* Hagen, from Ceylon, and *L. udeana* Krüger, from Sumatra. It is sufficiently distinguished from both by its size, being intermediate in this respect.

## EXPLANATION OF THE PLATES.

## PLATE V.

- Fig. 1. *Neurocena ida* ♀, p. 72.  
 2. *Onychothemis testacea* ♂, p. 75.  
 3. *Tetrathemis pulchra* ♂, p. 71.  
 4. *Idionyx dohrni* ♀, p. 78.  
 5. *Gomphus consobrinus* ♂, p. 80.  
 6. *Echo modesta* ♀, p. 84.

## PLATE VI.

- Fig. 1. *Gomphidia perakensis* ♂, p. 81.  
 2. End of abdomen of ditto.  
 3. *Sieboldius grandis* ♂, p. 82.  
 3a. End of abdomen of ditto.  
 4. Side view of thorax of ditto ( $\times 1\frac{1}{2}$ ).  
 5. *Climacobasis lugens*, fore wing, p. 85.  
 6. *Rhinocypha inas* ♂, p. 88.  
 7. *Micromerus affinis* ♂ ( $\times 1\frac{1}{2}$ ), p. 90.

3. List of a small Collection of Orthopterous Insects formed by Sir Harry Johnston in British East Africa and Uganda in 1899 and 1900, with Descriptions of Five new Species. By W. F. KIRBY, F.L.S., F.E.S., Assistant in the Zoological Department, British Museum (Natural History), South Kensington.

[Received November 28, 1901.]

The total number of species of Orthopterous Insects represented in the collection is 27, of which 23 are enumerated in the present paper, four species, probably new, remaining over for future consideration.

#### BLATTIDÆ.

##### BLATTINÆ.

##### DEROPELTIS.

*Deropeltis* Burm. Handb. Ent. ii. p. 486 (1838).

##### 1. DEROPELTIS MELANOPHILA.

*Ischnoptera melanophila* Walk. Cat. Blatt., Suppl. p. 146 (1869).

One male, from Baringo, 4000 feet, Dec. 20, 1899.

This species was described by Walker from Zanzibar. There are also specimens in the Natural History Museum from Samburu, British East Africa, from Mr. C. S. Betton's collection, and from Mombasa and Madagascar. This species differs from *D. erythrocephala* Fabr. by the black head, with only a streak within the antennæ, and the lower mouth-parts red.

#### POLYPHAGINÆ.

##### POLYPHAGA.

*Polyphaga* Brullé, Hist. Nat. Ins. ix. p. 57 (1835).

*Heterogamia* Burm. Handb. Ent. ii. p. 488 (1838).

##### 2. POLYPHAGA ÆGYPTIACA.

*Blatta ægyptiaca* Linn. Syst. Nat. (ed. x.) p. 424. n. 2 (1758).

One female specimen, Baringo, 4000 feet, Dec. 20, 1899.

Widely distributed in Africa and Southern Europe.

#### MANTIDÆ.

##### MANTINÆ.

##### TENODERA.

*Tenodera* Burm. Handb. Ent. ii. p. 534 (1838).

##### 3. TENODERA CAPITATA.

*Tenodera capitata* Sauss. Mitth. Schweiz. ent. Ges. iii. p. 69 (1869); Mém. Soc. Genève, xxi. p. 293 (1871).

Mount Ruwenzori; a large specimen measuring  $5\frac{1}{4}$  inches in expanse.

This species inhabits East and Central Africa and the Congo district.

#### VATINÆ.

##### POPA.

*Popa* Stål, Cefv. Vet.-Akad. Förh. xiii. p. 169 (1856).

##### 4. POPA UNDATA.

*Mantis undata* Fabr. Ent. Syst. ii. p. 19 (1793).

Mount Elgon; one specimen.

A well-known species in South Africa and Madagascar.

#### ACHETIDÆ.

##### CURTILLINÆ.

##### CURTILLA.

*Gryllotalpa* Latr. Hist. Nat. Crust. Ins. xii. p. 121 (1804), *nom. spec.*

*Curtilla* Oken, Lehrb. Nat. iii. p. 445 (1815).

##### 5. CURTILLA AFRICANA.

*Gryllotalpa africana* Beauv. Ins. Afr. Amér. p. 229, pl. 2. f. 6 (1805).

Two specimens, 4000 feet, Baringo, Dec. 20, 1899.

A widely-distributed African and East-Indian species.

#### ACHETINÆ.

##### ACHETA.

*Gryllus (Acheta)* Linn. Syst. Nat. (ed. x.) i. p. 428 (1758).

*Acheta* Leach, Edinb. Encycl. ix. p. 119 (1815).

##### 6. ACHETA BIMACULATA.

*Gryllus bimaculatus* De Geer, Mém. Ins. iii. p. 338, pl. 43. f. 1 (1773).

*Acheta capensis* Fabr. Syst. Ent. p. 281. n. 6 (1775).

Four specimens, Entebbe, Oct. 1900.

A common species throughout a great part of Southern Europe and Asia, and throughout all Africa.

#### PHASGONURIDÆ.

##### MECOPODINÆ.

##### ANÆDOPODA.

*Anædopoda* Karsch, Berl. ent. Zeitschr. xxxvi. pp. 333, 346 (1891).

##### 7. ANÆDOPODA LATIPENNIS.

*Mecopoda latipennis* Burm. Handb. Ent. ii. p. 686. n. 2 (1838).

Two specimens taken between Lake Victoria and Lake Tanganyika.

A common species in both East and West Africa.

#### HETRODINÆ.

##### ENYALIOPSIS.

*Enyaliopsis* Karsch, Berl. ent. Zeitschr. xxxi. p. 60 (1887).

##### 8. ENYALIOPSIS PETERSII.

*Hetrodes petersii* Schaum, Ber. Akad. Berl. 1853, p. 777; Peters's Reise Mossamb., Zool. v. p. 119, pl. vii. f. 7 (1862).

Three specimens, from Mounts Elgon and Ruwenzori.

A common species throughout East Africa.

#### LOCUSTIDÆ.

##### TRYXALINÆ.

##### ACRIDA.

*Gryllus (Acrida)* Linn. Syst. Nat. (ed. x.) i. p. 427 (1758).

##### 9. ACRIDA ACUMINATA.

*Acrida acuminata* Stål, Rec. Orth. p. 97 (1873).

Baringo, 4000 feet, Dec. 20, 1899.

Described from "Caffraria." Three old specimens in the Natural History Museum are from the "Cape of Good Hope."

##### PHLÆOBA.

*Phlæoba* Stål, Eugenie's Resa, p. 340 (1862).

##### 10. PHLÆOBA RUFESCENS, sp. n.

*Male*. Long. corp. 14 mm.; long. tegm. 9 mm.

*Female*. Long. corp. 21 mm.; long. tegm. 17 mm.

Rufo-testaceous; antennæ about 20-jointed, brown, except towards the base, subensiform, broadest for about six of the first joints of the flagellum and gradually tapering to the extremity; head above with two obsolete reddish lines, marked with a few black specks, diverging behind and continued still more indistinctly on the pronotum. Pronotum at least twice as long as broad; carinæ pale yellow, the lateral ones edged below with a black or reddish line: head with one or two indistinct reddish (or, in the male, blackish) lateral stripes, continued on the sides of the pronotum; these sides distinctly scabrous in the female, and marked towards the front below the lateral carina with two large smooth pits. On the upper surface the hinder lobe of the pronotum is punctured, the rest being nearly smooth; the hind sulcus is placed behind the middle, and the two front ones are widely interrupted in the middle, and only the second continued

on the sides. Tegmina hyaline with reddish nervures; hind tibiæ rather hairy, with eleven teeth on the outer edge.

Four specimens (1 ♂, 2 ♀, 1 nymph) from Baringo, Dec. 20, 1899.

There are several closely allied species from East Africa, of which one only (*P. alternata* Schulthess, nec Brunner) has hitherto been described.

#### PNORISA.

*Gomphocerus* (*Pnorisa*) Stål, Eugenie's Resa, p. 341 (1860).

##### 11. PNORISA CAPENSIS.

*Stenobothrus capensis* Walk. Cat. Derm. Salt. B.M. ii. p. 764. n. 62 (1870).

Fifteen specimens, Baringo, Dec. 20, 1901.

None of these specimens exactly agree with the unique type of the species, which is, besides, in rather poor condition; but they vary so much among themselves that I cannot consider them distinct. The males have indefinite longitudinal dusky markings on the head and thorax (chiefly on the sides) as in Walker's type; but the latter has the outer central area of the femora much more completely filled up with blackish than in any of the Baringo males, which have only isolated and variable blackish patches on that area, the largest towards the extremity. In the female there is a broad blackish band running backwards from the eye, over the sides of the pronotum, and a portion of the tegmina, and more or less distinctly bordered above and below by yellow lines. The central area of the hind femora is filled up externally in its upper half with a black stripe, broken into three parts, and is bordered on the upperside above by two longer and narrower black stripes.

#### LOCUSTINÆ.

##### CHLÆBORA.

*Chlæbora* Sauss. Mém. Soc. Genève, xxviii. (9) pp. 54, 132 (1884); xxx. (1) pp. 18, 19, 33 (1888).

##### 12. CHLÆBORA THALASSINA, sp. n.

Exp. al. 80 mm.; long. corp. 36 mm.

*Female*. Rufo-testaceous; carina of the pronotum very slightly raised, subobsolete behind, hinder half set with large granules, and shorter and more rounded behind than in *Humbe tenuicornis* Schaum. Tegmina with two oblique brown bands, the first at one-quarter of the length, and the second, much narrower and less complete, about the middle, bounding the outer subhyaline area. Costal area spotted with brown, especially about the first brown band. Beyond the lower extremity of the narrow outer band a series of linear blackish marks runs along the inner margin. Wings greenish yellow (possibly bright yellow in



perfectly fresh specimens) towards the base, followed by a broad, curved black band as in *Gastrimargus marmoratus*, extending to the anal angle and nearly touching the hind margin beyond the curve; apex of the wing hyaline.

One specimen, Mount Ruwenzori.

Closely allied to *C. kelleri* Schulth., from Somali, but the pronotum is broader, less strongly arched and carinated, and more rounded behind, and the black band on the hind wings is broader and more regular.

#### GASTRIMARGUS.

*Gastrimargus* Sauss. Mém. Soc. Genève, xxviii. (9) pp. 109, 110 (1884); xxx. (1) p. 37 (1888).

##### 13. GASTRIMARGUS MARMORATUS.

*Gryllus marmoratus*, var.  $\beta$ , Thunb. Mém. Acad. Pétersb. v. p. 232 (1815); ix. p. 410, pl. 14. f. 3 (1824).

*Pachytylus* (*Edaleus*) *marmoratus* Stål, Rec. Orth. i. p. 123 (1873).

*Edaleus marmoratus* Sauss. Mém. Soc. Genève, xxviii. (9) p. 112, n. 2 (1884); xxx. (1) p. 39, n. 3 (1888).

One specimen of var. *africana* Sauss. (Mém. Soc. Genève, xxx. (1) p. 39) between Lakes Victoria and Tanganyika.

##### 14. GASTRIMARGUS DETERMINATUS.

*Pachytylus determinatus* Walk. Cat. Derm. Salt. B.M. v. Suppl. p. 72 (1871).

*Edaleus verticalis* Sauss. Mém. Soc. Genève, xxviii. (9) p. 111 (1884).

Twelve specimens, Baringo, 4000 feet.

There are specimens in the Natural History Museum from the Cape, Knysna, Natal, and Marabastaat.

#### PHYMATINÆ.

##### PHYMATEUS.

*Phymateus* Thunb. Mém. Acad. Pétersb. v. p. 257 (1815).

##### 15. PHYMATEUS ÆGROTUS.

*Pœcilocera ægrota* Gerst. Arch. f. Nat. xxxv. p. 216 (1869).

Three discoloured specimens, taken between Lake Victoria and Lake Tanganyika.

A common species throughout East Africa.

#### DICTYOPHORINÆ.

##### TAPHRONOTA.

*Taphronota* Stål, Cefv. Vet.-Akad. Förh. xxix. p. 51 (1873).

##### 16. TAPHRONOTA GABUNICA.

*Taphronota gabunica* Karsch, Ent. Nachr. xiv. p. 358 (1888).

Mont Ruwenzori.

Two discoloured specimens, apparently belonging to this West-African species.

#### DICTYOPHORUS.

*Dictyophorus* Thunb. Mém. Acad. Pétersb. v. p. 258 (1815).

|| *Petasia* Serv. Ann. Sci. Nat. xxii. p. 278 (1831).

#### 17. DICTYOPHORUS ANCHIETÆ.

*Petasia anchietae* Bolivar, Jorn. Sci. Lisb. xxx. p. 110 (1882).

Three specimens from Entebbe, Oct. 1900.

Originally described from Angola, but apparently common in East Africa. There are specimens in the Natural History Museum from Abyssinia, Zomba, British East Africa, and Tanganyika.

#### PAMPHAGINÆ.

#### XIPHICERA.

*Xiphicera* Lamarck, Anim. sans Vert. iv. p. 243 (1817).

#### 18. XIPHICERA GIBBA, sp. n.

Long. corp. 37 millim.; long. pron. 17 millim.; long. fem. post.  $12\frac{1}{2}$  millim.; lat. 5 millim.

*Male.* Dark red; vertex longer than broad, granulated, sloping, and projecting in a point scarcely beyond the level of the lower part of the face, to which it slopes gradually down; antennæ, funiculus apparently 6-jointed (the three basal joints hardly separable), followed by a narrower joint but broader than long, two intermediate joints, the first shorter than the other, and the flagellum, which consists of only two joints, one longer than broad, narrowed at the base and truncated at the end, and the terminal joint linear. Pronotum very high, laterally compressed, granulated, pointed in front and bifid behind; in front it slopes upwards to a rounded-off obtuse angle before the middle, and then runs backwards to the extremity almost straight, the hinder part being obtusely denticulated. Tegmina and wings rudimentary; back of abdomen with small teeth on the median line. Hind femora granulated with white, and with the upper surface straight and serrated, the extremity truncated; the lower edge moderately broadly laminated, denticulated, and with a concavity before the extremity; hind tibiæ with strong short spines, eight on the outer edge.

A single specimen from between Lake Victoria and Lake Tanganyika. It would probably have fully-developed wings, if mature.

Allied to *X. spinulosa* Saussure and *X. haploscelis* Schaum.

#### MESAMBRIINÆ.

Two immature specimens from Baringo (Dec. 20, 1899), probably belonging to a new genus allied to *Mesambria* Stål.

## CYRTACANTHACRINÆ.

## CYRTACANTHACRIS.

*Cyrtacanthacris* Walk. Cat. Derm. Salt. B.M. iii. p. 550 (1870).

## 19. CYRTACANTHACRIS PALLIDICORNIS, n. n.

*Acridium ruficorne* Burm. (nec Fabr.) Handb. Ent. ii. p. 630. n. 9 (1838); Stål, Rec. Orth. i. p. 60. n. 2 (1873).

*Acridium succinctum* Serv. (nec Linn.) Ins. Orth. p. 642 (1839).

Seven specimens, between Lake Victoria and Lake Tanganyika. There is also an immature specimen in the collection, perhaps belonging to the same species, from Ruwenzori. This insect much resembles *Acridium tataricum* Stål (nec Linn., which probably = *Schistocerca peregrina* Oliv.).

## CATANTOPINÆ.

## CATANTOPS.

*Catantops* Schaum. Monatsb. Berl. Akad. 1853, p. 779.

## 20. CATANTOPS CAPICOLA.

*Aerydium (Catantops) capicola* Stål, Eugenie's Resa, p. 331 (1860).

*Catantops humeralis* Stål (nec Thunb.), Rec. Orth. i. p. 69. n. 1 (1873).

Baringo, 4000 feet, Dec. 20, 1901.

A rather large specimen, measuring 48 millim. in expanse.

## CALLIPTAMINÆ.

## EURYPHYMUS.

*Euryphymus* Stål, Rec. Orth. i. p. 72 (1873).

## 21. EURYPHYMUS CRASSUS.

*Caloptenus crassus* Walk. Cat. Derm. Salt. iv. p. 694. n. 39 (1870).

*C. illepidus* Walk. l. c. n. 40 (1870).

Var. *C. pinguis* Walk. l. c. n. 41 (1870).

Twenty specimens from Baringo, 4000 feet, Dec. 20, 1899.

Walker's specimens are from Natal, so far as they were labelled with any special locality.

## EUPREPOCNEMINÆ.

## HETERACRIS.

*Heteracris* Walk. Cat. Derm. Salt. B. M. iv. p. 655 (1870).

*Demodocus* Stål, Bihang Vet.-Akad. Handl. v. (4) p. 75 (1878).

As Stål's name *Demodocus* is preoccupied in Coleoptera, I propose to restrict Walker's name *Heteracris* to this genus.

22. *HETERACRIS BETTONI*, sp. n.

*Male*. Long. corp. 31–40 millim. ; long. al. ant. 14–15 millim. ; long. fem. post. 16–17 millim.

*Female*. Long. corp. 31–40 millim. ; long. al. ant. 20–34 millim. ; long. fem. post. 25–33 millim.

Chestnut-red, lighter in the male than in the female ; vertex much contracted between the eyes, with a shallow depression triangularly expanded on each side beyond the contraction : this is intersected by a slight carina, the continuation of the middle carina of the pronotum. Pronotum with the hinder lobe granulated ; in front of this portion extends a brown shade, divided by the central carina, and narrowing in front, but filling up most of the centre of the pronotum and vertex as far as the end of the depression on the latter. Head finely punctured ; sides of the pronotum more sparingly but more coarsely punctured than the hinder part, and with two very large pits below the lateral carina in front of the first suture, and behind these two others between the two sutures in the female, but only a still larger one in the male ; below this, on the middle of the central lobe of the pronotum, is an oblong yellow carina. Legs red, first and second pairs short, hind legs very long, femora with the basal half moderately thickened ; tibiae about as long as the femora, with from twelve to fourteen spines, slightly black-tipped, and gradually increasing in length from the base to the extremity. First and third joints of tarsi of about equal length, the first thickened in the middle, especially beneath ; the second about three-fifths as long. Tegmina brownish hyaline, with dark nervures and the outlines of several large spots ; some of the longitudinal nervures and intermediate spaces are reddish, especially above and below the central area ; in closed specimens the lower red stripe is seen to be continuous with the red borders of the pronotum. Wings clear hyaline, with brown and reddish nervures.

Described from three males and one female from Baringo (*Johnston*) ; one female from Maungu, B. E. Africa (*Betton*) ; one female from Thika-Thika, B. E. Africa (*Gregory*) ; one female from Mombasa (*Dr. J. Wilson*) ; one female from Atbara, Abyssinia (*purchased*).

The female from Baringo is smaller than any of the others.

Apparently allied to *Heteracris speciosa* Walk. from Sierra Leone, of which the Museum at present possesses only the type, an immature specimen.

## CALOPTENOPSIS.

*Caloptenopsis* Bolivar, *Jorn. Sci. Lisb.* (2) i. p. 173 (1889).

Head with the vertex between the eyes narrowed and tricarinate, the carinae very short, and formed by an oblong fovea on each side of the central carina ; beyond this point the vertex slopes smoothly into the broad frontal ridge, which is not sulcated but sparingly punctured, and is nearly straight. Thorax broad ; tricarinate, depressed, with the central carina higher than



the others; principal suture straight, a little in front of the middle; second suture curved backwards above and diverging from the hinder one on the sides; front suture scarcely continued on the sides, but there is a lateral suture near the front of the pleura, curving backwards below. Pectoral tubercle large and thick, obtusely rounded, broader than long. Pleura long, projecting a little on the middle edge below, and rounded. Hind femora thick, not much narrowed towards the extremity and denticulated above. Hind tibiae with six outer and eight inner spines, and provided with five terminal spines; the middle one inferior, as long as the metatarsus, hairy, with a strong tooth on the upper surface before the extremity. Metatarsus trilobate beneath; second joint short above, but with a projection below the base of the terminal joint; the latter is slender, with large claws and pulvillus, and a little shorter than the metatarsus. Male with the cerci very broad, somewhat spatulate at the extremity, and furnished with a short black terminal tooth on the outer side. Female with the upper appendages longer than the lower ones and hooked upwards at the extremity; the lower appendages hooked downwards.

A remarkable and interesting genus, which I had characterized as new before recognizing its identity with *Caloptenopsis*; and as my definition was already in print, I have allowed it to stand. My definition, of course, is taken from *C. johnstoni*.

There are now several species of *Caloptenopsis* known, chiefly from East and Central Africa.

### 23. *CALOPTENOPSIS JOHNSTONI*, sp. n.

Long. corp. ♂ 17, ♀ 21 millim.; exp. al. ♂ 25, ♀ 40 millim.

Rufo-testaceous; face not carinated, clypeus broad below, with a black spot at each lower angle. Pronotum varied with blackish in the middle above, especially in front; the inner borders of the lateral carinae closely punctured; the hinder lobe and the meta-pleura thickly and closely punctured. Front of the pleura, below the lateral carinae, with two large pits, the first double, below these is a brown curved band, ceasing at the hinder suture; below it is a second but shorter brown stripe. The colour of the pleura is paler than the upper part of the pronotum. Subalary spaces with large punctures. Both surfaces of the hind femora with curved or slightly angulated black lines, followed by black dots on the carinae; the spaces between the outer and middle carinae above and between the three lower carinae unspotted. Upper curve of the knees black on both sides, space below this yellowish. Tibial spines rather small and tipped with black. Wings brownish hyaline, interspersed with brown network-patterns in the middle, becoming more macular towards the extremity; anal area with reddish nervures.

Described from three males and four females from Baringo, Dec. 20, 1899.



February 18, 1902.

Prof. G. B. HOWES, LL.D., F.R.S., Vice-President,  
in the Chair.

Mr. L. W. Byrne, F.Z.S., called the attention of the Meeting to the description of *Lepidogaster stictopteryx*, a supposed new species of Sucker-fish, which had been given by Mr. E. W. L. Holt and himself in a communication made to the Society on November 15th, 1898, and made the following remarks:—

On November 15th, 1898, we exhibited before this Society (P. Z. S. 1898, p. 589) specimens of a *Lepidogaster*. We supposed them to be attributable to a new species, for which we suggested the name of *L. stictopteryx*.

The examination of further specimens has convinced us that we have been guilty of adding further confusion to the synonymy of the species of this genus, and that our *L. stictopteryx* is not specifically distinct from *L. microcephalus* Brook, the synonymy of which should stand as follows:—

LEPIDOGASTER MICROCEPHALUS.

*L. microcephalus* Brook, Proc. Roy. Phys. Soc. Edin. x. p. 166, pl. vii. (1888).

? *L. bimaculatus* ♂, Guitel, Comptes Rendus, cxl. p. 759 (1890).

*L. stictopteryx* Holt & Byrne, P. Z. S. 1898, p. 589.

Fortunately our friend Professor Guitel, of Rennes, is continuing his studies upon this genus, and informs us that he has obtained at Roscoff material which he believes will enable him to deal with the question in a satisfactory manner. Under these circumstances we feel it would be superfluous for us to do more than correct our own mistake, and we have entrusted our notes, drawings, and material to his most able hands.

Mr. W. B. Tegetmeier, F.Z.S., exhibited and made remarks upon the skull of a supposed hybrid between the Sheep and the Pig, named "Cuino"<sup>1</sup> by the inhabitants of Mexico, where it was extensively reared as an agricultural animal. The skull was clearly that of a Pig.

Dr. C. I. Forsyth Major, F.Z.S., exhibited some jaws and teeth of Pliocene Voles (*Mimomys*, gen. nov.), from the Norwich Crag at Thorpe, and from the Upper Val d'Arno; and made the following remarks:—

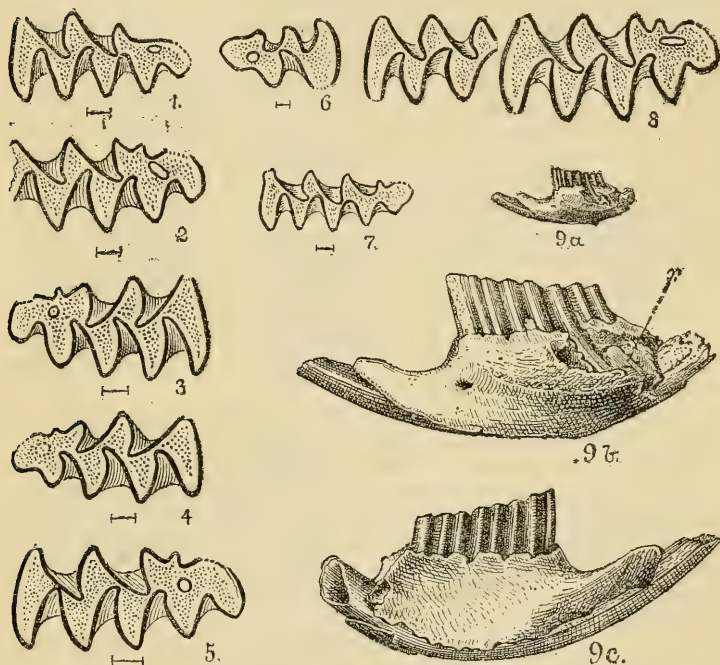
The Pliocene remains of Voles here exhibited—a mandibular ramus from the lacustrine beds of the Upper Val d'Arno in Italy, and over forty bits from the Norwich Crag at Thorpe,

<sup>1</sup> For information respecting this supposed hybrid see 'Field,' vol. xcvi. (1900) p. 497, and xevii. (1901) p. 233.

mostly isolated teeth—are so minute and fragmentary, that I have to supplement my demonstration by sketches.

The jaw from the Val d'Arno (text-fig. 13, nos. 8, 9), containing two anterior rooted molars, was mentioned by me upwards of twenty years ago. The first lower molar (text-fig. 13, no. 8) exhibits in its anterior portion an enamel islet, which is a very strange feature in a Vole's molar. I am sorry to trouble members with such a minute detail; but almost the whole interest centres around this insular eccentricity, so to

Text-fig. 13.



H. G. del.

Teeth and jaws of Tertiary Voles.

Figs. 1-5 & 7 represent the first lower molars, upper view.—Fig. 1. *Mimomys intermedius* (Newt.), West Runton Forest Bed (B. M. No. 6968 d, from Savin Coll. No. 1705): left side.—Figs. 2 & 3. *Mimomys pliocenicus* (Maj.), Norwich Crag, Thorpe (Norw. Castle Mus. No. 971): fig. 2, left side; fig. 3, right side.—Figs. 4 & 5. *Mimomys pliocenicus* (Maj.), Norwich Crag, Thorpe (Norw. Castle Mus. No. 551, from Fitch Coll.): fig. 4, right side; fig. 5, left side (figured by E. T. Newton, 'Forest Bed,' pl. 13. fig. 13).—Fig. 6. *Mimomys pliocenicus* (Maj.), third upper molar, left side; East Runton Forest Bed (B. M. No. 6967, from Savin Coll. No. 464).—Fig. 7. *Mimomys newtoni*, sp. n., East Runton Forest Bed (B. M. No. 6967 a, from Savin Coll. No. 430): left side.—Fig. 8. *Mimomys pliocenicus* (Maj.), first and second lower molars, upper view; Upper Val d'Arno, Italy (Florence Museum).—Fig. 9 a. The same specimen, outer view of the mandible, nat. size.—Fig. 9 b. The same enlarged,  $r$ =root of  $m^2$ .—Fig. 9 c. The same mandible, inner view, enlarged.

speak, of the fossil tooth. I had before met with a similar feature in one of two very young teeth of the recent *amphibius*-group, from Pisa, which presumably belonged to Savi's *Arvicola destructor*. In the recent tooth the enamel islet showed a slightly different position and genesis, was quite superficial and therefore ephemeral; it was associated with some other complications—two additional shallow enamel-loops—which likewise approach the tooth of the very young *amphibius* to that of the Pliocene form. In the recent species this pattern is very soon worn away; there is no more trace of it in slightly older specimens. This is a fresh instance of a recent form preserving in the younger stages of its molar the features of a Tertiary form.

When during the revision of the fossil Rodentia of the British Museum, the Microtidae of the Forest Bed came to be studied, I was anxious to ascertain whether the enamel islet occurred there too in adult specimens, as is the case in the Val d'Arno fossil.

Mr. E. T. Newton has published an elaborate description of the Rodents of the Forest Bed and Norwich Crag, and has shown that the larger Voles are, by the presence of well-developed fangs to their molars, very distinct from the *amphibius*-type with which they had been confused by all previous writers. He who enjoys the advantage of standing on his predecessor's solid shoulders, has also the duty to try and see a little farther, especially when additional material has accumulated in the meantime. If, therefore, to-day a step forward is possible in the knowledge of the Pliocene Voles, it is but fair to acknowledge that this is in a great measure due to Mr. Newton's previous work.

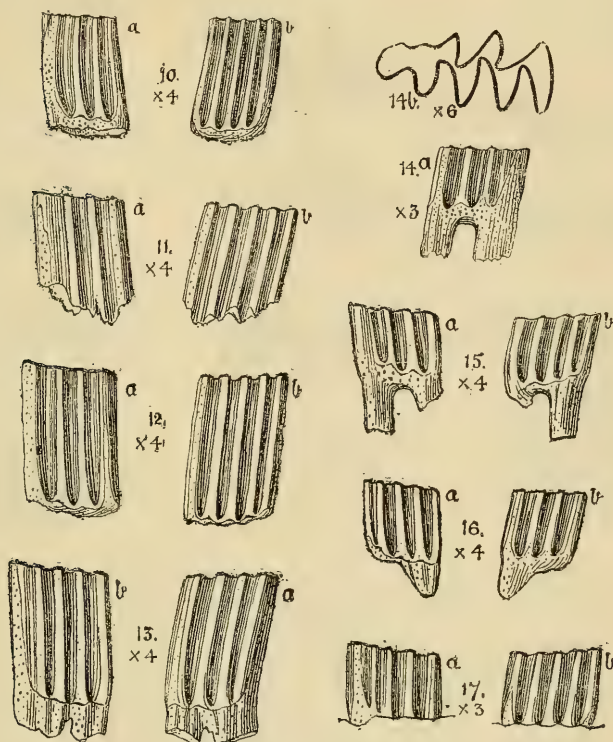
Among the Voles' teeth of the Savin Collection from the Forest Bed, I found the character alluded to, but only in a relatively small number of teeth (*e.g.* text-fig. 13, no. 1) and in different proportions according to the localities. Whilst among 55 first molars from the West Runton Upper Freshwater Beds only four showed the character in question, the number of teeth provided with enamel islets was larger among the less numerous Voles' remains from the East Runton Forest Bed, and, moreover, other features became apparent.

From the Norwich Castle Museum I have received of late, through the kindness of Mr. Leney, a small number of teeth and two jaws, here exhibited, which were collected by Mr. Fitch in the Norwich Crag at Thorpe (text-figs. 13, nos. 2-5; 14, no. 15; 15, nos. 20, 29). Here the presence of the enamel islet is the rule: there are ten anterior lower molars in this small series—eight exhibit the islet, one is very old and apparently has lost every trace of it; the tenth, a very young tooth (text-fig. 15, no. 29), reveals the genesis of the islet, which is the central portion of the antero-external enamel fold. Moreover, the teeth are of two different sizes.

In short, the result of the investigation is, that the Voles of the Norwich Crag are different from those of West Runton and are represented by two species; whereas at East Runton the

West Runton type occurs together with the Crag types. The larger of the Crag-forms is besides represented by specimens from Bramerton (text-fig. 14, nos. 14 *a*, *b*) and from Kyson in Suffolk.

Text-fig. 14.



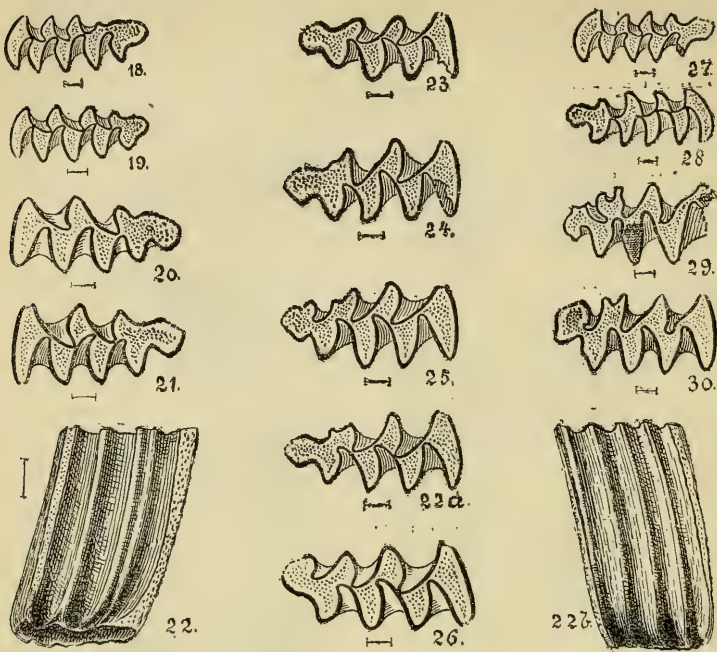
Teeth of Tertiary Voles, enlarged.

Figs. 10-17. Views of first lower molars. *a*=outer aspect, *b*=inner aspect (except 14 *b*=upper view).—Fig. 10. *Mimomys newtoni*, sp. n., same specimen as fig. 7.—Fig. 11. *Mimomys intermedius* (Newt.), same specimen as fig. 1.—Fig. 12. *Mimomys intermedius* (Newt.), same specimen as fig. 21.—Fig. 13. "*Mimomys intermedius* (Newt.)," same specimen as fig. 26, right side; West Runton (B. M. No. 6968 *e*, from Savin Coll. No. 1705).—Fig. 14 *a*. *Mimomys pliocenicus* (Maj.), Norwich Crag, Bramerton (Norwich Castle Mus. No. 728, from Reeve Coll.).—Fig. 14 *b*. The same, upper view.—Fig. 15. Same specimen as fig. 20, *Mimomys pliocenicus* (Maj.), Norwich Crag, Thorpe (Norwich Castle Mus. No. 971).—Fig. 16. *Mimomys newtoni* (?), East Runton Forest Bed (B. M. No. 6967 *b*, from Savin Coll. No. 464).—Fig. 17. *Mimomys pliocenicus* (Maj.), same specimen as fig. 5.

For the present I content myself with three specific names, calling (1) *pliocenicus* the larger Crag-form, which I identify with the one from the Val d'Arno; (2) *newtoni*, a smaller rooted



Text-fig. 15.



H. G. del.

*Teeth of Voles from Forest Bed and Norwich Crag.*

Figs. 18-21, 22 a, 23-30, first lower molars, upper view, enlarged.

- Fig. 18. *Microtus*, sp., recalling somewhat *M. gregalis*; rootless, left side; West Runton (B. M. No. 6987 a, from Savin Coll. No. 1708).—Fig. 19. *Microtus nivaloides*, sp. n., recalling *M. nivalis*, but smaller and anterior loop more produced; left side; rootless (B. M. No. 6987 b, from Savin Coll. No. 1708).—Fig. 20. *Mimomys pliocenicus*, same specimen as fig. 15: left side, enamel islet vanishing.—Fig. 21. *Mimomys intermedius*, same specimen as fig. 12; West Runton (B. M. No. M 6968 a, from Savin Coll. No. 1692): left side, cement-spaces closed below, but roots not yet developed.—Fig. 22. *Mimomys intermedius*, first lower molar, right side, outer aspect; West Runton (B. M. No. 6968 b, from Savin Coll. No. 1692): cement-spaces closed below, but roots not yet developed; fig. 22 a. Same specimen, upper view; fig. 22 b. Same specimen, inner aspect.—Fig. 23. *Mimomys newtoni*?, East Runton; same specimen as fig. 16.—Fig. 24. *Mimomys intermedius*, right side; East Runton (B. M. No. 6967 c, from Savin Coll. No. 465): cement-spaces, with the exception of the antero-external, still open below.—Fig. 25. *Mimomys intermedius*, right side, young; West Runton (B. M. No. M 6968 c, from Savin Coll. No. 1692): cement-spaces narrowing below, but not closed (the lower end of the tooth is incomplete from break). From an inspection of the outer side it becomes evident that by progress of wear the anterior enamel fold would soon have been reduced to an ephemeral enamel islet.—Fig. 26. *Mimomys intermedius*?, same specimen as fig. 13, right side; West Runton.—Fig. 27. *Microtus* sp., recalling *M. arvalis*: left side, rootless; West Runton (B. M. No. M 6987 c, from Savin Coll. No. 1708).—Fig. 28. *Microtus* (*Pitymys*) sp., right side, rootless; West Runton (B. M. No. M 6987 d, from Savin Coll. No. 1708). Behind the anterior loop follows a transverse loop resulting from the union of the third outer and the fourth inner prism (counting from behind). This loop is separated from the anterior loop by the meeting in the middle line of the third outer and the fourth inner reentrant angle; features characteristic of the European members of the subgenus *Pitymys*.—Fig. 29. *Mimomys pliocenicus*, young, right side, posterior portion broken off; Norwich Crag, Thorpe (Norw. Castle Mus. No. 971: Fitch Collection). The antero-external reentrant angle not yet reduced to an enamel islet. Cement-spaces beginning to be closed below.—Fig. 30. *Mimomys pliocenicus*, young, right side (Norwich Mus. No. 2708: from Gurney Collection). "Upper Freshwater Bed, Ostend." Cement-spaces closed below; no roots developed. Enamel islet not yet formed.



form from the Norwich Crag and East Runton (text-fig. 13, no. 7), which has characters of its own; (3) Mr. Newton's name *intermedius* is restricted to the form or forms met with at West Runton (text-figs. 13, no. 1; 14, nos. 11-13; 15, nos. 21, 22, 25, 26) and a few from East Runton (text-fig. 15, no. 24). I am, however, quite convinced that at least double this number of species ought to be recognized, and am only prevented from doing so at present because I do not wish to found species on isolated teeth.

The larger Crag species is mainly characterized by the presence of the enamel islet, except in quite old specimens; by the earlier development of fangs; by the presence of an enamel islet in the last upper molar also; and by the presence of three roots in the two anterior upper molars, whereas in *M. intermedius* these same teeth have only two roots.

The four anterior lower molars of *M. intermedius*, in which the islet occurs, are all very little worn, although full-grown. It is therefore probable that the enamel islet will be found to be a constant feature in the young teeth of *M. intermedius*, but more ephemeral than in *M. plioccenicus*. I propose to form a distinct genus, *Mimomys*, for all these Voles with rooted molars, which are clearly different from *Eotomys*, *Phenacomys*, and *Dolomys*. *M. newtoni* may prove, hereafter, to form a distinct genus.

In the Savin Collection there are, besides those already referred to, about 17 fragmentary jaws and a small number of isolated teeth of *Microtus*, provided with rootless teeth throughout life; with one exception, a single anterior lower molar tooth from East Runton, they all came from the West Runton Upper Freshwater Beds. There are at least four different forms; several of them show in the conformation of their lower anterior molar some resemblance to such living forms as *M. arvalis* (text-fig. 15, no. 27), *M. nivalis* (text-fig. 15, no. 19), and *M. gregalis* (text-fig. 15, no. 18). On closer inspection I find, however, that, with the single exception of one isolated tooth, I can refer none of these remains to any recent nor to any hitherto known fossil species. The majority of the rami, ten in number, have nothing to do with the subgenus *Microtus*, but show in their anterior lower molar a feature (text-fig. 15, no. 28) which is characteristic of the European and some of the American members of *Pitymys*, and is found almost identical in the North-American *Pedomys*.

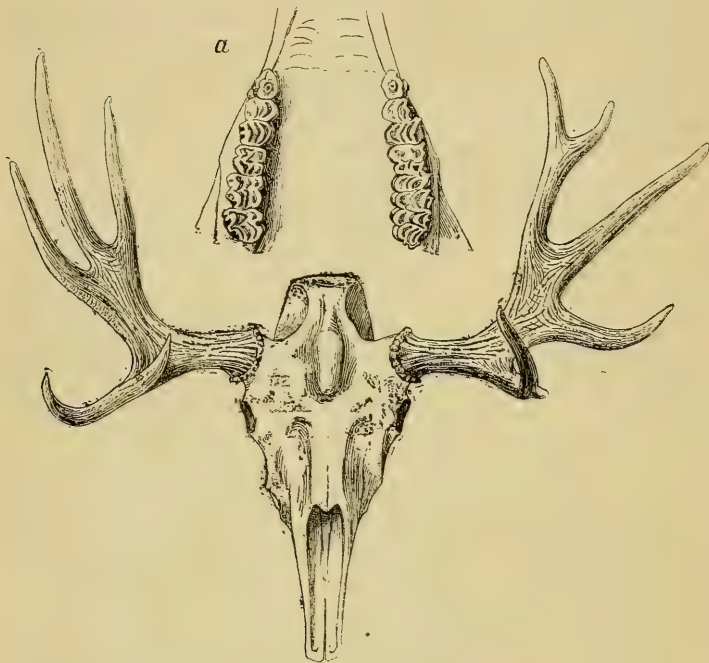
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Mr. Lydekker exhibited the skull and antlers (text-fig. 16, p. 108) of an adult male Elk from Siberia, together with the antlers of a second example, lent by Mr. Rowland Ward.

The skull indicated an animal of at least 6 or 7 years old, the cranial sutures being for the most part obliterated, while the cheek-teeth were about half-worn. It was that of a somewhat older animal than the one to which an American skeleton mounted in the British Museum belonged. In the latter the palmation of the

antlers was well developed ; but in both the pairs of antlers exhibited there was practically no palmation. These antlers were in fact very like those of young Scandinavian Elk, only with the palmation still less. They showed three tines on each side on the upper or hinder half of the main bifurcation, and either one or two tines on the lower or front branch. Mr. Lydekker had been informed that other Elk-antlers from Siberia were of a similar type.

Text-fig. 16.

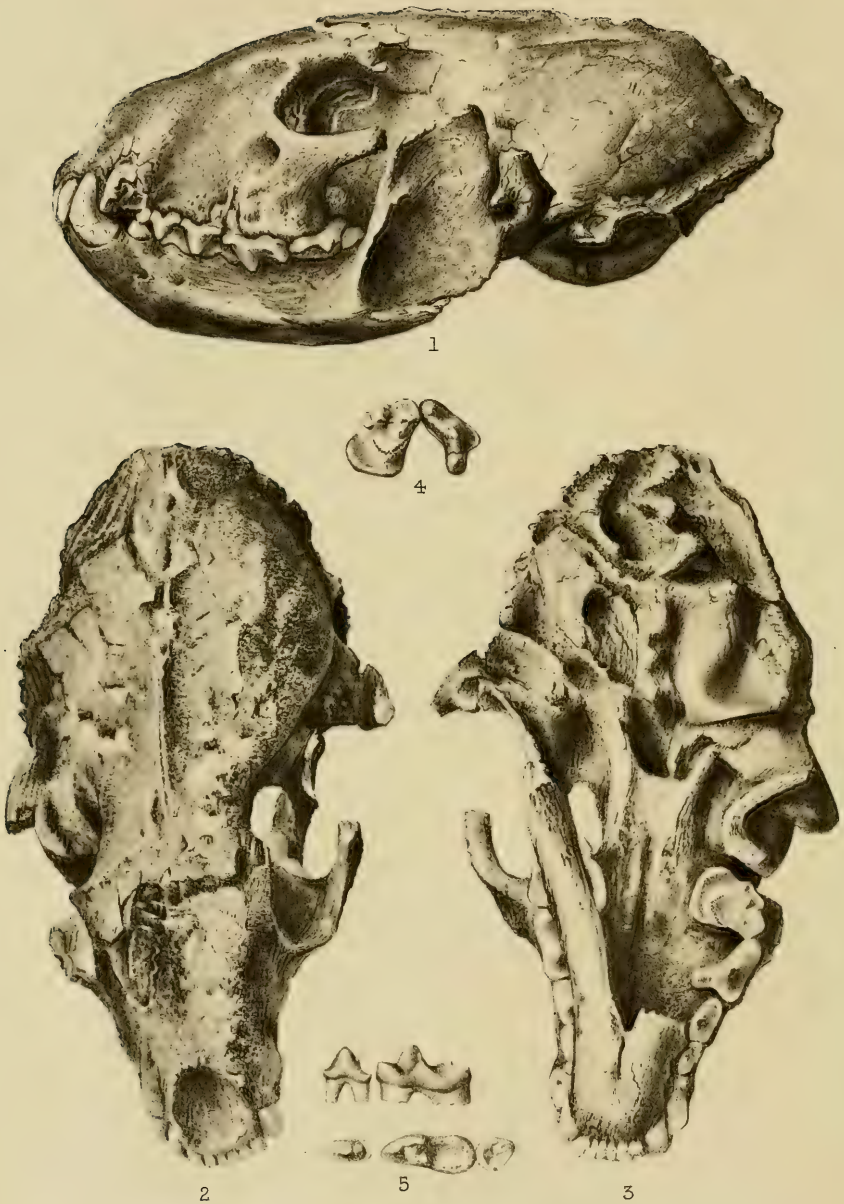


Skull and antlers, with the upper cheek-dentition (*a*), of Siberian Elk.  
From the type specimen in the Museum at Tring Park.

That the specimens exhibited were not the result of senile decadence was quite evident, not only from the symmetrical form of the antlers themselves, but likewise from the state of wear of the cheek-teeth (text-fig. 16, *a*) of the skull.

The similarity of the two pairs of antlers, together with the information as to this type being characteristic of all Elk-antlers from the same country, induced Mr. Lydekker to regard the Elk of Siberia as a distinct form. Whether it should be considered a species or a variety was a somewhat difficult question ; but since the antlers exhibited involved a modification in the definition of the genus, it seemed advisable to allow specific rank in this case,





H. Grönvold, del.

Photogravure by Bale & Danielsson, L.<sup>nd</sup>

SKULL OF *MUSTELA PALÆATTICA*.

Although in a recently published work Mr. Lydekker had suggested the possibility of the Siberian Elk proving distinct, so far as he was aware it had not yet received a name. An Elk with antlers not unlike those of the specimens exhibited had been described in 1847 by Rouillier, in Fischer de Waldheim's 'Jubilæum,' under the name of *Alces resupinatus*, based on a skull from a Pleistocene deposit in Russia. There did not appear, however, to be any characters by which that specimen could be distinguished from young skulls of the Scandinavian Elk.

Under these circumstances Mr. Lydekker proposed to name the Siberian Elk *Alces bedfordiæ*, in honour of the wife of the President of the Society. This species would be distinguished from both the Scandinavian and American races of *Alces machlis* by its non-palmated antlers, which carried only four or five times on each side. The complete specimen exhibited would form the type.

The occurrence in Siberia of an Elk with antlers of the simple type of those exhibited was a fact of considerable interest, since that country was probably the centre whence both the European and American races of the true Elk were evolved.

[P.S.—Since this exhibition took place Mr. Lydekker had seen five other pairs of Elk-antlers from Siberia, all of the same form. Three of these specimens, together with the two exhibited, had been acquired by Mr. Walter Rothschild.

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The following papers were read :—

1. On *Mustela palæattica* from the Upper Miocene of Pikermi and Samos. By C. I. FORSYTH MAJOR.

[Received December 17, 1901.]

(Plate VII.<sup>1</sup>)

The type of Weithofer's *Mustela palæattica*<sup>2</sup>, from Pikermi, is in the Vienna Museum. It is represented by a badly crushed skull (of which, however, the teeth, minus the incisors, are very well preserved), by the two almost intact mandibular rami, and by part of the skeleton. The whole was kept together and preserved from total destruction by being lodged between the rami of a *Hipparion* mandible.

The characteristic features of this species are furnished by the conformation of the upper and the talon of the anterior lower molar. Whilst the posterior upper premolar (*p.1*) bears the characteristic features of *Mustela*, in its elongate outlines and the

<sup>1</sup> For explanation of the Plate, see p. 114.

<sup>2</sup> A. Weithofer, "Beiträge zur Kenntniss der Fauna von Pikermi bei Athen." [Beitr. Pal. Oesterreich-Ungarns, vi. pp. 226-231, pl. x. figs. 1-11 (1888).]



anteriorly situated small inner cusp, separated by a constriction from the blade, the molar approaches somewhat *Meles* by being more extended antero-posteriorly than in the recent species of *Mustela* proper, and by the presence of a third cusp to the inner side of the postero-external tubercle. Likewise, the lower *m. 1* has its talon more complicated than in *Mustela*.

In the same year as Weithofer's publication I identified with his species an incomplete skull (the facial part missing)<sup>1</sup> which I had discovered in the contemporaneous deposits of Samos, in the locality Andrianò near the village Mitylini.

Schlosser<sup>2</sup> discusses Weithofer's type under the heading "*Meles? (Mustela) palaeattica*," and unites with it an isolated upper molar, also from Pikermi, which he had formerly been disposed to regard as "*Martes pentelici* Gaudry," and which therefore bears this name in the explanation of his plate viii. (fig. 16). Two years later<sup>3</sup> Weithofer's type was registered by Schlosser as *Meles palaeatticus*.

Von Zittel in his turn proposes for it the new generic name *Promeles*, and places it with the *Melince*<sup>4</sup>; whereas Winge refers *Promeles* to the *Mustelince*, and places it side by side with "*Martes*"<sup>5</sup>.

In the Geological Museum of Turin I came upon the skull of a small Carnivore from Pikermi, which had been received many years before. It was kindly intrusted to me by Professors Parona and Sacco, and proved, when cleaned, to belong to the same species as the one described by Weithofer. Being so much more complete than my specimen from Samos, I have preferred to describe and figure the Turin specimen rather than the latter.

The skull is somewhat laterally compressed and otherwise distorted. Both zygomata are incomplete, the left one less than the right. The principal lesion is in the lateral region of the right side, the posterior part of the frontal and the parietal being lost. The mandible was in its natural position, and so firmly adhering to the skull, that to detach it as a whole would have been impossible without endangering the teeth. I determined therefore to sacrifice part of the right mandibular ramus—which was already damaged—rather than spoil the teeth, and succeeded in developing satisfactorily the *m. 1*, *p. 1*, and *p. 2* of the right upper, and the *m. 2*, *m. 1*, and *p. 1* of the right lower jaw.

Weithofer assigns to his specimen the size of *Mustela martes*, only slightly more robust; the teeth as figured show no signs of wear. The Turin specimen shows the teeth moderately worn, and, as will appear from the measurements, it was slightly larger than

<sup>1</sup> C. Rendus, 31 Dec. 1888, p. 1179. It is no. 272 of Mr. W. Barbey's collection at Valleyres (Switzerland). See Forsyth Major, 'Le Gisement ossifère de Mitylini et Catalogue d'Ossements fossiles recueillis à Mitylini, Ile de Samos,' p. 27, no. 272 (1894).

<sup>2</sup> Pal. Oesterr.-Ung. viii. p. 352 (1888).

<sup>3</sup> *Id. op. cit.* viii. p. 469 (1890).

<sup>4</sup> Handbuch der Palaeont. iv. p. 690 (1890).

<sup>5</sup> E Museo Lundi, (2) iv. pp. 66, 69 (1895).

the former. On comparing Weithofer's figure 1 (pl. x.) with my figures (Pl. VII.), the difference in size would appear still greater; but I find that the size of his figure does not in every respect correspond with the measurements given in the text, whereas, on the other hand, the statement on p. 228, that the upper series of cheek-teeth have together a length of 34 millim., is obviously a misprint: presumably we have to read 24 millim.

	Turin. mm.	Vienna. mm.
Greatest length of upper molar ( <i>m. 1</i> ) ...	7·5	6·5
"    breadth                      "                      "	10·5	10·0
"    length of upper carnassial ( <i>p. 1</i> )	9·2	9·0
"    breadth of <i>p. 1</i> underneath principal cusp <sup>1</sup> .....	4·0	3·7
Length of upper <i>p. 2</i> .....	6·0	6·0 <sup>2</sup>
"    " <i>p. 3</i> .....	4·3	4·0 <sup>3</sup>
"    " <i>p. 4</i> .....	2·5	

Length of the cheek-teeth series in the Turin specimen, from posterior border of third cusp of *m. 1* to anterior margin of *p. 3*, 25·5 millim.

	Turin. mm.	Vienna. mm.
Length of mandibular ramus (from anterior basis of canine to condyloid process) .....	57·0	56·5
Height of coronoid process .....	29·0	29·0
From lower margin of foramen magnum to anterior basis of incisors .....	ca. 79·0	
From hinder margin of teeth-series to posterior palatal emargination .....	10·0	
Length of lower <i>m. 2</i> .....		
"    " <i>m. 1</i> .....	12·4	11·8
"    " <i>p. 1</i> .....	6·5	6·3
"    " <i>p. 2</i> .....	5·0	4·8
"    " <i>p. 3</i> .....	4·5	4·3
"    "    canines at basis .....	5·7	

The six upper *incisors* are in place in the Turin specimen (Pl. VII. fig. 3); the anterior portion of the mandible remaining attached to the skull, only their anterior side is visible. They correspond perfectly with the incisors of *Mustela*, without any trace of the tricuspid condition of the blades exhibited by the upper incisors of *Meles*, *Mydaus*, *Helictis*, *Mephitis*, and *Canepatus*.

The upper *canines* are both broken, only the stumps remaining. Weithofer describes the upper canines of the Vienna specimen as being "etwas hakig nach rückwärts gebogen." In the *Melinae* the upper canines are more in the shape of a dagger, the backward

<sup>1</sup> The tooth of the Turin specimen being worn, the measurement of height is omitted.

<sup>2</sup> Weithofer terms this tooth *p. 1*.

<sup>3</sup> Weithofer, sub *p. 2*.

curvature of the Musteline canines being absent or scarcely appreciable.

The anterior *premolar* (p. 4), absent in the Vienna skull, is present on both sides in the Turin specimen. I have nothing to add to Weithofer's description of the two following premolars (p. 2 and p. 3).

The perfectly Musteline character of the *upper carnassial* (p. 1) has already been mentioned. The only difference, already pointed out by the Austrian palæontologist, from recent species of *Mustela* is in the outer contour, which is almost convex in the fossil, slightly concave in recent species. The inner cusp is less constricted than in *M. martes*, *M. zibellina*, and *M. pennanti*, but resembles in this respect the *M. foina*.

Of the *upper molar* (n. 1) Weithofer says that it is different from that of all the other Mustelidæ, and he describes it minutely as follows<sup>1</sup>:—"Er ist bedeutend stärker entwickelt, mehr complicirt in der Richtung gegen den Dachs hin, ist überhaupt nur ein verkürzter Dachszahn mit allen den Elementen, die diesen charakterisiren. Die beiden äusseren Tuberkel des Marderzahnes sind viel stärker, stehen in ihrer Entwicklung in der Mitte zwischen Marder und Dachs und überdies ist bereits auch der dritte äussere Tuberkel des Dachszahnes vorhanden. Von diesem zieht sich eine höckerige, in zahlreiche kleine Tuberkel aufgelöste Wulst gegen innen, und, an der Innenseite des Zahnes, gegen vorne, welche in dieser Weise ebenfalls nur beim Dachs auftritt, noch nicht aber beim Marder. Zum Unterschiede von ersterem theilt sie sich jedoch in ihrem Verlaufe an der Innenseite rückwärts in zwei Aeste, welche beide die erwähnte grobe Körnelung besitzen. Der beim Dachs in der Mitte dieses Zahnes auftretende, von der Vorderecke ausgehende Kamm, der sich meist in drei Höcker auflöst und dessen Aequivalent beim Marder nur ein einfacher kleiner Tuberkel ist, ist hier auch als ziemlich langer, bogenförmig gekrümmter Kamm ausgebildet. Die Gesamtform des Zahnes ist eine mehr parallelopipedische, wenigstens ist die Vorder- und Hinterkante vollständig gleichlaufend, welche beim Marderzahn nach aussen stark convergiren. Es ergibt sich daraus eine besondere Ausdehnung des Aussenrandes, während der Innenrand nur wenig grösser ist als beim Marder."

On comparing this minute description and the figure of the tooth (pl. x. fig. 1) with the specimen at my disposal (Pl. VII. figs. 3 & 4), we have to bear in mind that the teeth of the Vienna specimen are scarcely touched by wear, and that the granulations of the talon, of which there are only traces remaining in the worn tooth of the Turin specimen, are quite as conspicuous in unworn molars of recent *Mustelas* as they are in the Vienna tooth. The general form of the molar is dumbbell-shaped in *M. martes*, *M. zibellina*, *M. pennanti*, and *M. foina*. In Weithofer's specimen the outer and inner margins run perfectly parallel

<sup>1</sup> *Op. cit.* p. 228.

to each other, but in the Turin specimen there is a slight emargination on the posterior margin, internally from the third cusp; and the same may be seen in a fine skull of *M. palæattica* from Pikermi, which forms part of Dr. A. Smith Woodward's recent successful excavations at Pikermi. In the Valleyres, Turin, and London specimens the interior margin of the tooth is slightly more elongate than the exterior, so that the anterior and the posterior margins converge slightly towards the outer sides. Conversely, in the Indian Martens (the *M. flavigula*-group) "this molar differs in form from that in *M. foina* and *M. martes* by having the inner lobe no broader from back to front than the outer."<sup>1</sup>

On the whole the fossil tooth differs from the molars of the *martes*-group by slight characters only. Now, the only reason for collocating the fossil within the *Meline* has been the shape of this upper *m. 1*, with which of course goes hand in hand that of the talon of the lower *m. 1*. It is, however, to be considered that a tooth situated at the posterior end of the series is always liable to vary more or less, and within the *Meline* in particular this tooth is by no means characteristic for the group. In *Helictis* it is quite narrow, the inner part not broader than the outer and the anterior and posterior margin almost parallel. In *Meles* the outer margin is much shorter than the inner, so that in this respect *Meles* agrees more with *Mustela martes* and allied species. In *Mephitis* and allies there is no trace of a third cusp, which, on the other hand, is present, although feebly developed, in the unworn molars of some species of *Mustela* (e. g., *M. pennanti*, *M. zibellina*), as also in unworn specimens of the South-African *Mellivora* (*M. ratel*), as well as in the *Vison*.

Far more characteristic is the upper carnassial (Pl. VII. figs. 3 & 4). In the *Musteline* and in "*Promeles*" it shows the elongate form and the small anterior talon-cusp. The region of the cheek is more sharply separated than in recent *Mustela* from the nasal region by a blunt arcuate ridge, and in relation with this the depression in front of the orbits and above the infraorbital foramen is deeper.

The anterior and posterior roots of the zygoma rise almost vertically, so that the zygoma is shown to have a highly arcuate form, just as in *Mustela*.

The palate is more prolonged behind the molar series than in the recent species.

The under contour of the mandible is slightly more arcuate in the fossil than in *M. zibellina* and *M. martes*, and even more than in *Mustela foina* as described.

In all the *Meline* the carnassial is short and often provided with two or three talon-cusps. When there is only one (*Mephitis*), this is placed opposite the middle of the blade, and on either side connected by a cingulum with the antero- and the postero-

<sup>1</sup> W. T. Blanford, 'The Fauna of British India'—Mammalia, p. 159 (1888).



external margin of the blade, so that a valley is formed between the inner and the outer part of the tooth.

By the conformation of its upper carnassial, therefore, the fossil is excluded from the *Melineæ*—the upper and the lower one making only a slight approach towards the form they have in some members of this subfamily; whilst the characters of the skull and of the skeleton, so far as known, bring it likewise in closer connection with the *Mustelineæ* and with *Mustela* in particular. To emphasize this, it seems preferable to leave it in the latter genus, viz., to revive the name by which it was originally described—*Mustela paleattica* Weith.

#### EXPLANATION OF PLATE VII.

Skull of *Mustela paleattica* Weith., from Pikermi; Geological Museum, Turin.

All figures of the natural size.

Fig. 1. Side view. Fig. 2. Upper view. Fig. 3. Lower view. Fig. 4. Posterior upper premolar and molars, right side. Fig. 5. Lower true molars and posterior premolar, right side.

#### 2. On Two new Genera of Rodents from the Highlands of Bolivia. By OLDFIELD THOMAS, F.R.S.

[Received January 28, 1902.]

(Plates VIII. & IX.<sup>1</sup>)

Mr. Perry O. Simons, the collector who has been doing such admirable work in the Andean chain, and to whose efforts we owe the discovery of a very large number of the mammals of that interesting region, has now sent home a collection from the high grounds of South-western Bolivia, from the Departments of Oruro, Potosi, and Sucre. Among these, besides some new species of known genera, described elsewhere, there are examples of two rodents so distinct as to demand generic separation, and I have therefore thought them worthy of being brought before the Society for description and illustration.

#### NEOTODON, gen. nov. (*Octodontidæ*.)

Tail comparatively bushy. Palms and soles granulated, the pads imperceptible.

Palatal foramina longer than in *Octodon*, the actual openings, instead of only the outer fossa, penetrating into the maxillæ.

Incisors smooth, comparatively thick antero-posteriorly, their depth rather more than  $1\frac{1}{2}$  their breadth, as compared with about  $1\frac{1}{8}$  in *Octodon*.

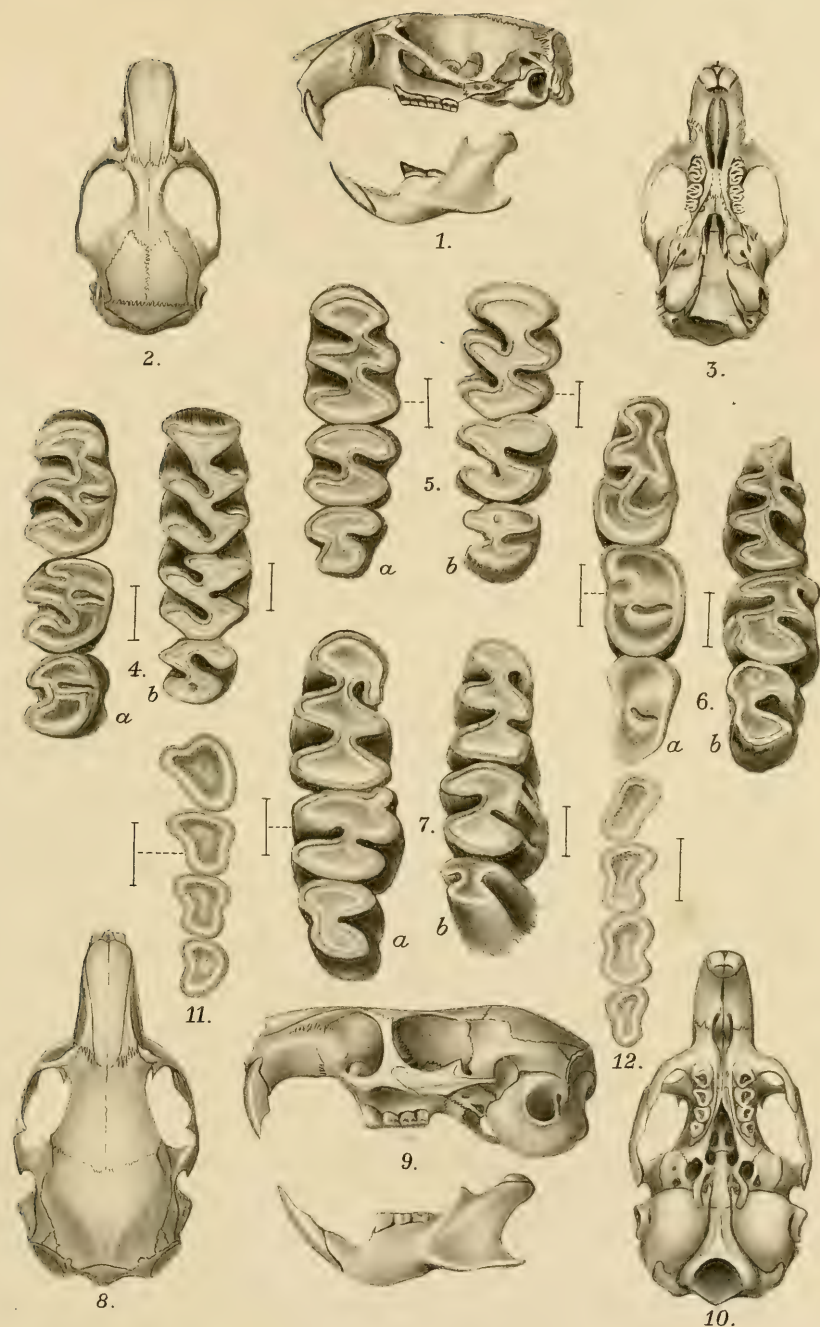
Molars rootless, simpler than in *Octodon*, with a slight concavity on their outer side and none on the inner, there being no trace

<sup>1</sup> For explanation of the Plates, see p. 117.









H. Grönvold, del.

Photogravure by Bale & Danielsson L.<sup>ts</sup>

1, 2, 3, 4<sup>a</sup> & 6<sup>a</sup> ANDINOMYS EDAX, ADULT; 4<sup>b</sup> & 6<sup>b</sup> YOUNG OF D<sup>r</sup>  
 5<sup>a</sup> & 7<sup>a</sup> CHINCHILLULA SAHAMÆ, ADULT; 5<sup>b</sup> & 7<sup>b</sup> YOUNG OF D<sup>r</sup>  
 8-12, NEOCTODON SIMONSI, ADULT.



of the deep internal enamel infolding found in that genus. The premolar rounded, triangular in section. Lower teeth oval in section, a slight median constriction on each side of  $m_1$  and  $m_2$ .

This genus is, no doubt, closely allied to *Octodon*, of which it is a highland representative.

NEOCTODON SIMONSI, sp. n. (Plates VIII. & IX. figs. 8-12.)

General appearance very much as in the North-American *Neotoma cinerea*, strikingly different, by paler colour, whiter belly, and longer, more bushy tail, from either of the species of *Octodon*. Fur soft and fine, hairs of back about 22 mm. in length.

General colour above pale drab-grey, grizzled with black. Sides clearer drab. Under surface snowy white, well defined laterally, where it extends rather high up; the bases of the hairs slaty except on the chin. Front of upper lip hairy, not grooved. Face coloured like the back, paler on the sides of the muzzle and cheeks; no definite markings round eyes. A few longer vibrissæ placed just above eye, and a more prominent tuft of them between eye and ear. Ears large, shaped about as in *Octodon*, finely covered with short greyish hairs; a distinct tuft of white hairs at their anterior bases. Outer sides of arms and legs like back, inner sides like belly; upper surface of hands and feet pure white, the hairs stiff and elongated terminally, so as to surpass the claws; palms and soles entirely naked, strongly granulated, with projecting cushions, on which the pads are so small as to be scarcely perceptible among the granulations; under the heel the surface is comparatively smooth; pollex with a broad flat nail; hallux short, with a claw, its tip falling some way short of the base of the second digit; fifth toe, without claw, reaching to the end of the basal phalanx of the fourth. Scrotum naked. Penis with a bone, which is flattened, tapering, though not to a point, about 15 mm. in length. Tail nearly as long as the head and body, thick, cylindrical, well clothed throughout with hairs, which increase in length to the end, where they may be fully an inch long. In colour the tail is brownish black above and at the end, white proximally on the sides and below; the hairs of the pencil-end are usually pale brown or even sandy brown, but this appears to be an effect of bleaching, more or less dependent on the season, as is the case in the British Squirrel.

Skull and teeth as shown in the figures.

Dimensions of the type, measured by Mr. Simons in the flesh:—

Head and body 184 mm.; tail 152; hind foot, s. u. 36, c. u. 38; ear 32.

Skull—greatest length 46, basilar length 38, greatest breadth 24; nasals  $17 \times 5.8$ ; interorbital breadth 10; length of frontal suture 13.5; breadth of brain-case 18.5; palate length 17.2; diastema 12; palatal foramina  $4.8 \times 2.4$ ; length of upper tooth-series (crowns) 8.3; length of bulla 13; breadth of basi-occipital on suture 2.6.



*Hab.* Mountainous region south and south-east of the Titicaca-Poopo basin. Potosi, 4400 metres (type); Oruro, 3700 m.; Livichuco, 4500 m.; Challapata, 3800 m.

*Type.* Adult female. B. M. No. 2.2.2.2. Original number 1620. Collected October 1st, 1901, by Mr. P. O. Simons. 15 specimens examined.

Native names "Chockchuri" and "Achaco." "Found among rocks and cactus, in caves and old Indian tombs; nocturnal" (*Simons*).

I have had great pleasure in connecting with this very beautiful animal the name of Mr. Simons, in recognition of the remarkable collecting work he has done in the Andean chain during the last three years. His collections already number over 1600 mammals, more than 3000 birds, many hundreds of reptiles and amphibians, and large numbers of insects and other invertebrates.

#### ANDINOMYS, gen. nov. (*Cricetinae*.)

Form murine. Thumb with a broad nail. Tail well-haired, but not pencilled.

Skull rat-like. Muzzle long, broad, and heavy. Interorbital region narrow, parallel-sided, without ridges. Palatal foramina large, with very sharply defined edges. Bullæ small.

Incisors heavy, smooth anteriorly. Molars very large, highly hypsodont, as in *Chinchillula*, but their pattern more as in *Phyllotis*, though with almost a microtine appearance in youth, when they are much more complicated than would be at all easily perceived from their structure in adult life (see figures).

This genus, like *Chinchillula*<sup>1</sup>, is a highly hypsodont and heavily toothed relative of *Phyllotis*, itself more hypsodont than the brachyodont *Eligmodontia*. But in *Chinchillula* the teeth are remarkably simple, practically alike in youth and age, with opposite and connected enamel-spaces, as shown in the figures (Plate IX. figs. 5, 7). In *Andinomys*, on the other hand, the spaces are more or less alternated, the pattern, especially of  $m_1$ , becomes less complicated with age owing to the wearing-out of accessory columns, and the spaces are or gradually become isolated from each other; the lateral angles are much more acute in youth, becoming comparatively blunt in old age.

#### ANDINOMYS EDAX, sp. n. (Plate IX. figs. 1-4, 6.)

General appearance of a large *Phyllotis* or soft-haired *Oryzomys*. Fur long, fine and soft, but not woolly; hairs of back about 19-20 mm. in length. General colour above dull buffy or fulvous buffy, lined with black; sides clearer, sandy buffy; under surface not sharply defined, buffy white, the hairs slaty basally. Head like body; no orbital markings. Ears fairly large, closely haired, brown

<sup>1</sup> *Chinchillula* was originally founded (Ann. Mag. N. H. (7) i. p. 280, 1898) on a single immature skin, but the British Museum now possesses a series of adult examples collected by Mr. Simons at Caylloma, Peru.

outside and in, their edges whitish. Upper surface of hands and feet well-haired, the hair of the ends of the digits surpassing the claws, silvery white; fifth hind toe, without claw, reaching to the middle of the second phalanx of the fourth; palms and soles naked, the pads large, rounded and prominent.

Skull with large nasals, very broad anteriorly. Interorbital region narrow, parallel-sided, concave in the middle line, the concavity bordered by low rounded and inconspicuous ridges, which do not overhang the orbit or run back on to the parietals. Interparietal large and broad. Anterior plate of zygoma-root concave anteriorly, with an overhanging point above. Palatal foramina very long and open, broadest mesially, running to a sharp point behind, where they reach to the level of the first lamina of  $m^1$ , their edges very sharp and clearly defined. Posterior nares level with the back of  $m^3$ , comparatively broad. Bullæ small.

Dimensions of the type, measured in the flesh by Mr. Simons:—

Head and body 160 mm.; tail 145; hind foot, s. u. 29, c. u. 30; ear 25.

Skull—greatest length 37; basilar length 31; nasals  $15.2 \times 6.1$ ; interorbital breadth (on the convex surface low down) 4, between the rudimentary ridges 2.1; breadth of brain-case 14; interparietal  $4.3 \times 10$ ; zygoma-root 3; palate length 18; diastema 10.1; palatal foramina  $9.6 \times 3.2$ ; length of upper molar series 7; combined breadth of upper incisors 3.

*Hab.* El Cabrado, between Potosi and Sucre, Bolivia. Altitude 3700 metres.

*Type.* Old female. B. M. No. 2.2.2.15. Original number 1568. Collected September 20th, 1901, by P. O. Simons. Two specimens.

A young specimen, apparently of the same species, had been previously obtained by Mr. Simons at La Paz, altitude 4000 m.

Mr. Simons says of this animal: "Caught in thicket of oak-like bushes; nocturnal."

Owing to its extreme general resemblance to *Phyllotis*, the young specimen from La Paz had been supposed to be an example of that genus with a wrongly numbered skull, but the later examples prove that Mr. Simons was in this instance, as usual, entirely correct in his labelling.

## EXPLANATION OF THE PLATES.

### PLATE VIII.

*Neotodon simonsi*, p. 115.

### PLATE IX.

Figs. 1, 2, 3. *Andinomys edax* (p. 116), skull.

Fig. 4. *Andinomys edax*, right upper tooth-row: *a*, adult; *b*, young.

5. *Chinchillula sahamae* (p. 116), right upper tooth-row: *a* & *b* as before.

6. *Andinomys*, right lower tooth-row: *a* & *b* as before.

7. *Chinchillula*, right lower tooth-row: *a* & *b* as before.

Figs. 8, 9, 10. *Neotodon simonsi* (p. 115), skull.

Figs. 11, 12. *Neotodon*, right upper and right lower tooth-rows.

## 3. On some new Mammals from Northern Nyasaland.

By OLDFIELD THOMAS, F.R.S.

[Received February 4, 1902.]

Since my last paper on the mammal-fauna of Nyasaland, a number of further specimens from that country have been contributed to the National Museum by Mr. Alfred Sharpe, C.B., Commissioner, and Col. Manning, Deputy Commissioner, collected by themselves, Mr. J. McClounie, Mr. J. B. Yule, Capt. Pearce, and others.

Without occupying space by recording the known species sent, the present paper, the seventh of the series, gives descriptions of the new species contained in the collection.

Opportunity has also offered for a re-examination of the Nyasan *Colobus*, and, as it proves to be new, it is now described.

*COLOBUS SHARPEI*, sp. n.

Coloration exactly as in *C. palliatus* Peters<sup>1</sup>, to which this species has hitherto been referred. Pelage rather closer and longer, the hairs of the middle back 5-6 inches in length and those of the mantle 10-12.

Skull decidedly larger in every dimension than that of *C. palliatus*. Frontal region much more convex, and also as it were higher up the skull, so that the middle point between the ridges is in side view over  $m^2$  or  $m^3$ , while in *C. palliatus* it is over  $m^1$ ; the distance from the same spot to the tip of the nasals is nearly half as much again in the new form (23 mm. as against 16), and the nasals themselves are both longer, broader, and less acutely pointed behind. Zygomata stronger, the vertical height of the malar just in front of the squamosal suture 10 instead of about  $5\frac{1}{2}$  or 6 mm. Zygomatic arches strongly divergent posteriorly, nearly parallel in *C. palliatus*. Front edge of coronoid process of lower jaw angularly convex forwards. The other cranial differences observable seem all to be dependent on the greater size of *C. sharpei*.

Dimensions (approximate) of a stuffed specimen, not the type:—Head and body 680 mm.; tail 760; hind foot 190.

Dimensions of the typical skull, that of an old female:—Greatest length in middle line 115 mm.; condylar length, from back of condyles to gnathion, 101; zygomatic breadth 85; nasal opening, height 21, breadth 10; nasals, length in middle line 16, breadth 10; least interorbital breadth 10; orbit, height 26, breadth 27; vertical height from palate to frontal behind supra-orbital ridges 38.5; palate length from gnathion 49.5; combined length of upper premolars and molars 33.6, of upper molars 23, of lower premolars and molars 38, of lower molars 25.

*Hab.* Nyasa-Tanganyika Plateau. *Type* from Fort Hill.

<sup>1</sup> Figured, MB. Ak. Berl. 1879, p. 832, pl. iv A.

*Type.* Old female. B.M. No. 97.7.3.1. Collected by J. B. Yule, and presented by Alfred Sharpe, Esq., C.B.

It has always been a matter of surprise that the *Colobus* of the high Nyasa-Tanganyika plateau should be the same as that occurring in the hot lowlands opposite Zanzibar, but the markings are so nearly identical that no one has hitherto been able to separate the two forms. Now, however, that the British Museum has received from Mr. A. B. Percival three fine adult females of the true *C. palliatus* from Takaungu, British East Africa, with their skulls, I am able to show that the two are separable, the skull-differences being really considerable.

I have much pleasure in naming this fine species after my friend, Mr. Alfred Sharpe, C.B., Commissioner of British Central Africa, to whose interest and patriotism the National Collection of Nyasan Mammals is so largely indebted.

*Colobus sharpei* is the *C. angolensis* of Sclater (1892), and more recently the *C. palliatus* of Pousargues, Neumann, and myself.

#### HELOGALE VARIA, sp. n.

Size rather large. Fur close and fine. General colour above finely speckled yellowish or buffy grey, passing gradually below into deep buffy without speckling. Posterior back of all four specimens, in bleached pelage, dull yellowish or "clay-colour." Head conspicuously different to back, clear deep grey without yellowish suffusion; a small patch on each side of the muzzle running back to surround the eye brown or brownish rufous. Ears grey above, deep yellowish below. Upper surface of hands and feet dark yellowish clay-colour, scarcely grizzled at all. Tail coloured like back.

Skull with the nasals broad and parallel-sided for their anterior half, then abruptly narrowing to a point posteriorly.

Dimensions (approximate) of the type, measured in skin:—Head and body 270 mm.; tail 162; hind foot (wet) s. u. 46; ear (wet) 18.

Skull (of the type, nasal sutures still showing)—greatest length in middle line 53; zygomatic breadth 28.5; nasals 9 × 5; interorbital breadth 9.1; breadth of brain-case above meatus 19.7; palate length from gnathion 24.5; greatest diameter of  $p^4$  5.2.

*Type.* Sub-adult. B.M. No. 2.1.6.5. Four specimens examined.

This *Helogale*, of which four perfectly similar specimens are in the collection, differs from all others by the head being much darker-coloured than the back, these parts being quite concolor in the other forms. Whether the much greater yellowness of the rump will also prove a constant character I cannot say, as in all the skins the fur of this part is worn and faded.

The recognizable forms of *Helogale* seem to be as follows:—

#### (1) *HELOGALE ATKINSONI* Thos.

*Helogale atkinsoni* Thos. Ann. Mag. N. H. (6) xx. p. 377 (1897).



Face, crown, and back uniformly grizzled grey. Under surface dull greyish brown, more fulvous on throat and inguinal region. Feet grizzled greyish proximally, fulvous on digits.

*Hab.* Abyssinia and Somali.

(2) *HELOGALE UNDULATA* Peters.

*Herpestes undulatus* Peters, Reise Mossamb. p. 114, pl. xxv. (1852).

Body grizzled greyish, more or less suffused with rufous. Face, especially muzzle, strongly rufous. Crown like back. Under surface dull greyish brown. Hands and feet deep rufous.

*Hab.* British East Africa, German East Africa, and Mozambique.

(3) *H. VICTORINA*, sp. n.

Body pale grizzled grey, suffused with ochraceous yellow. Muzzle fulvous. Crown like back. Under surface from chin to anus dull buffy yellow. Hands and feet also buffy yellow. Tail like body above, buffy below.

Head and body of type 243 mm.; tail 145; hind foot, s. u. 44. Skull—greatest length 52; zygomatic breadth 31; palate length 2.5; greatest diameter of  $p^1$  5.5.

*Type.* Male. B.M. No. 93.5.1.2. Collected October 25, 1892, by the Rev. F. C. Smith. Presented by Canon Tristram. Three specimens examined.

*Hab.* Region of the Victoria Nyanza. *Type* from Nassa, on Speke Gulf, south end of the lake. Usambiro, Victoria Nyanza (*Emin Pasha*).

(4) *H. VARIA* Thos.

As above.

(5) *H. PARVULA* Sund.

*Herpestes parvulus* Sund. Öfv. K. Vet.-Ak. Förhandl. 1846, p. 121.

Size small. Colour uniformly dark, finely grizzled brown throughout, on head, body, belly, and limbs.

*Hab.* S.E. Africa: Natal, Zululand, &c.

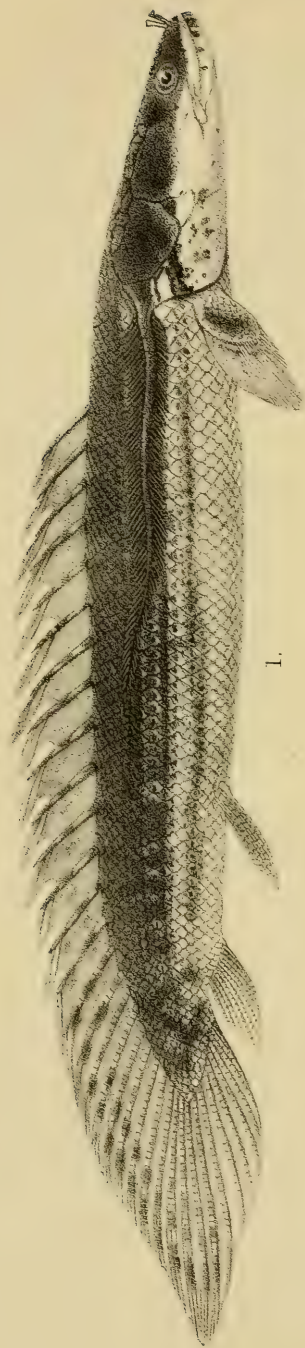
*FUNISCIURUS YULEI*, sp. n.

No stripes. Premolars  $\frac{2}{1}$ .

Superficial appearance somewhat as in *F. cepapi*. Size rather larger than in that species. Fur of medium harshness; hairs of back about 10 mm. in length. General colour above pale coarsely grizzled tawny, greyer over the shoulders, though this may be due to old age. Sides greyish tawny, much lighter than the dorsal area, though the line of distinction is not sharply defined. Under surface ill-defined whitish, whiter on the chest and groins, mixed with greyish on the belly. Sides of muzzle and rings round eyes whitish. Crown grizzled tawny. Ears comparatively







1.



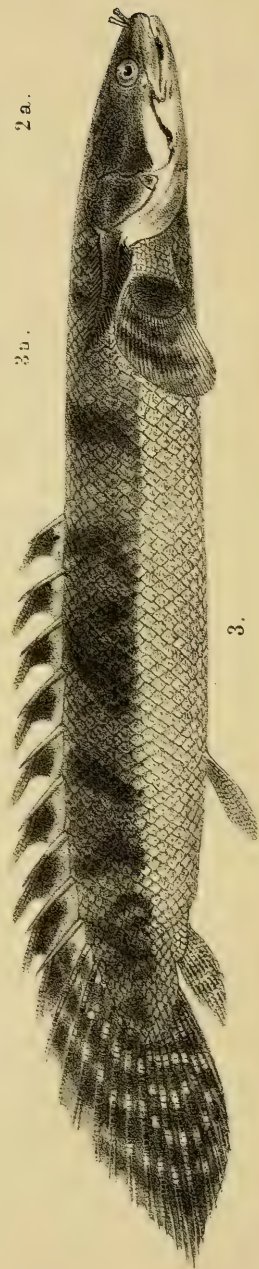
2 a.



2 b.

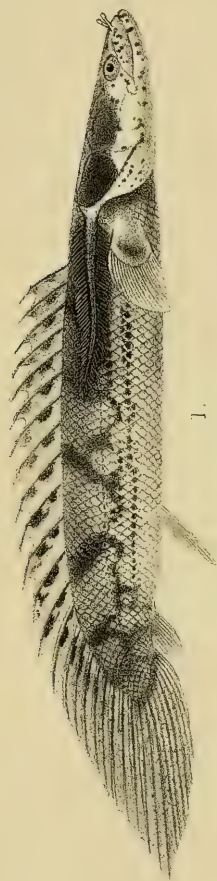


2.

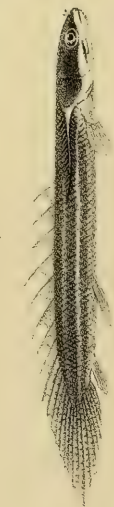


3.





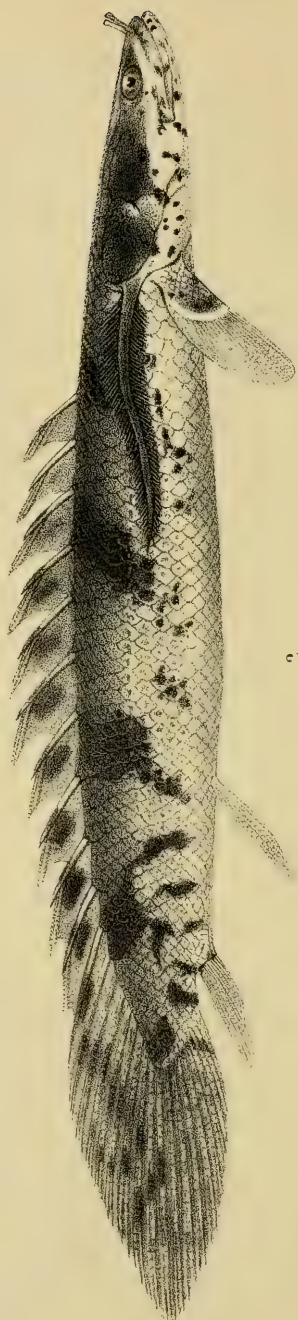
1.



3.



4.



2.

large, whitish, especially at their edges. Arms and legs like sides; hands and feet heavily built, their upper surfaces greyish white; soles naked except under the heels. Tail but little bushy, its hairs broadly ringed with black and pale yellowish, their tips whitish.

Skull rather heavier than that of *F. cepapi*. Nasals broad, expanded posteriorly. Interorbital region broad, flat or slightly concave; postorbital processes well developed, projecting directly outwards instead of backwards. Premolars  $\frac{2}{1}$ . Molars heavier than in *F. cepapi*.

Dimensions (approximate) of the type, measured in skin:—Head and body 205 mm.; tail 145; hind foot s. u. (wet) 41; ear (wet) 19.

Skull—henselion to basilar suture 28; nasals, length 12·5, least breadth 5, posterior breadth 6; interorbital breadth 12; tip to tip of postorbital processes 19; intertemporal breadth 13; palate length from henselion 18·5; diastema (to front of  $p^1$ ) 10·6; length of tooth-row (omitting the small  $p^3$ ) 8. Lower jaw, condyle to incisor-tip 27·7.

*Hab.* Muezo, near Lake Mweru.

*Type.* Old male. B.M. No. 2.1.6.8.

It is difficult to say to which species *F. yulei* is really most closely allied. Externally it has a certain resemblance to *F. annulatus*, but that animal has only one upper premolar and differs in many other details. From *F. cepapi*, found in the same region, it is distinguished by its larger ears, grey instead of fulvous limbs, whitish feet, larger molars, and other points both external and cranial.

I have connected with this distinct Squirrel the name of Mr. J. B. Yule, of the official staff of the Protectorate, by whom a large number of the North Nyasa specimens described now and in former papers have been collected.

#### 4. On some Characters distinguishing the Young of various Species of *Polypterus*. By G. A. BOULENGER, F.R.S.

[Received January 28, 1902.]

(Plates X. & XI.<sup>1</sup>)

The increased interest which has lately been paid to the remarkable African Crossopterygian *Polypterus* has resulted in a better understanding of the characters by which the species can be distinguished<sup>2</sup>, and the recent exploration of the Congo has added several forms, fully entitled to specific rank, which were undescribed<sup>3</sup>.

<sup>1</sup> For explanation of the Plates, see p. 125.

<sup>2</sup> Cf. Boulenger, Ann. & Mag. N. H. (7) ii. 1898, p. 416.

<sup>3</sup> Cf. Boulenger, Poiss. du Bass. du Congo (1901), and Ann. Mus. Congo, Zool. ii. (1902).



We can now distinguish ten *Polypteri*:—

1. *P. bichir* Geoffr.—Nile.
2. *P. lapradii* Sldr.—Senegal, Gambia, Niger.
3. *P. congicus* Blgr.—Congo, L. Tanganyika.
4. *P. endlicheri* Heck.—Nile, Niger.
5. *P. delhezi* Blgr.—Congo.
6. *P. ornatipinnis* Blgr.—Congo.
7. *P. weeksii* Blgr.—Congo.
8. *P. senegalus* Cuv.—Nile, L. Rudolf, Senegal, Gambia, Niger.
9. *P. palmas* Ayres.—West Africa, from Liberia to the Congo.
10. *P. retropinnis* Vaill.—Congo.

Not before 1869 was anything known of the characters of the young. We owe the first observations on this subject to Steindachner<sup>1</sup>, who, on his return from a collecting expedition to the Senegal, announced the startling discovery that both *P. lapradii* and *P. senegalus* are provided, for a certain period, with a large external opercular gill similar in structure to those possessed by Tailed Batrachians. In 1896<sup>2</sup>, I noticed the presence of external gills in *P. palmas*, and successively in specimens of *P. congicus*, *lapradii*, and *weeksii*<sup>3</sup>. In his highly interesting memoir on the Breeding-habits of some West-African Fishes<sup>4</sup>, Mr. Budgett has made us acquainted with the external appearance of a specimen, referred by him to *P. lapradii* (but which he informs me, after examination of the Nigeria specimens sent by Dr. Ansoerge, should be referred to *P. senegalus*), smaller than any previously obtained and which may be regarded as truly larval. Having recently received, from various sources, a number of young specimens from the Nile, the Congo, and Nigeria, I am able to supplement our present knowledge on various points. The notes here offered deal with six species: *P. lapradii*, *P. congicus*, *P. endlicheri*, *P. weeksii*, *P. senegalus*, and *P. palmas*. It will be observed that the young of *P. bichir*, the oldest known species, the only one to occur in the Lower Nile, is still undescribed.

Before proceeding to descriptive details, I wish to observe that the specimens with external gills at present known may be arranged in three divisions:—(1) Without scales, and with the dorsal fin spineless, not differentiated from the caudal; the only example known being the larval specimen of *P. senegalus*, brought home from the Gambia by Mr. Budgett and described and figured by him. (2) With scales of a cycloid type and with the dorsal fin as in the preceding. (3) With all the essential characters of the mature form. Although the scales may, in the very

<sup>1</sup> Sitzb. Akad. Wien, lix. i. 1869, p. 103.

<sup>2</sup> Ann. & Mag. N. H. (6) xvii. 1896, p. 310.

<sup>3</sup> Ann. & Mag. N. H. (7) ii. 1898, p. 419, and P. Z. S. 1898, p. 493, 1899, p. 554, 1900, p. 267.

<sup>4</sup> Trans. Zool. Soc. xvi. 1901, p. 115.

young, differ so greatly in shape, their numbers are the same as in the adult, and, though devoid of spines and in no way "pinnules," the rays of the dorsal fin are identical in number; only, as it is practically impossible to establish a limit between them and those of the caudal, it is preferable to count the rays right to the extremity of the vertebral column.

*POLYPTERUS LAPRADII* Stdr. (Plate X. figs. 1 & 2.)

This is one of the largest species, growing to a length of 740 millim. The largest specimen with fully developed opercular gills, obtained by the late P. Delhez at Kaédi, Senegal, measures 300 millim., and is the largest *Polypterus* with external gills yet recorded; the specimens in which the external gills were discovered by Steindachner measured up to 230 millim. These gills are retained, as a rule, until the young is 240 to 260 millim. in length, but they vary in the degree of development irrespective of the size of the specimen, and sometimes also on the two sides.

Four young specimens, measuring 94, 98, 114, and 205 millim. respectively, were obtained at Assay and Abo, Southern Nigeria, in October last by Dr. W. J. Ansorge, to whom ichthyology is indebted for so many striking discoveries in that part of Africa.

In the smallest specimen the external gill measures 30 millim., the dorsal rays are all simple and spineless, 23 in number, and the scales are very thin, circular, juxtaposed, and only well developed about the lateral line and on the tail; the caudal fin is acutely pointed, the median rays being produced and as long as the head. A black band extends on each side from the end of the snout, through the eye, to the base of the external gill, which is likewise black, and along the body to the base of the caudal fin; this band, on the body, is about as broad as the eye; below it a narrower black band extends from the shoulder to the anal fin. In the two next specimens the external gills measure 33 and 50 millim. respectively. In the largest specimen, the right external gill measures 68 millim., the left 53; the scales are well developed, rhomboidal and imbricate, and the dorsal spines (14 in number, followed by 10 soft rays to the extremity of the vertebral column) are ossified and bicuspid, supporting three articulated rays to form the "pinnule." The dark bands are more indistinct and crossed by bars on the caudal region.

*POLYPTERUS CONGICUS* Blgr. (Plate XI. fig. 1.)

This species appears to be the largest of the genus, growing to one metre. I have already reported upon specimens up to 260 millim. provided with the external gill, and one of them has been figured in the 'Annales du Musée du Congo.' It appears that in this species, as in *P. lapradii*, the external gills are normally retained until comparatively late. A specimen recently received from Banzyville on the Ubangi, and belonging to the Congo Museum, is interesting as being the smallest yet obtained of that species.

It measures 118 millim., the external gill being 25 millim. long. In its development it is intermediate between the two stages noticed above in *P. lapradii*. The dorsal spines are not yet defined, the number of rays being 22 to the extremity of the vertebral column; the scales are imbricate, cycloid, with a tendency to the rhomboid shape, rugose, with a smooth central area corresponding to the part of the scale first to appear. Six blackish bars across the back, bifurcating on the sides; below these bars, two interrupted blackish lines run along each side.

**POLYPTERUS ENDLICHERI** Heck. (Plate XI. fig. 2.)

I have seen only one young specimen of this *Polypterus*, obtained at Abo, Nigeria, by Dr. Anson in October. It measures 180 millim., the external gill 30, and corresponds in its development with the largest specimen of *P. lapradii* obtained by Dr. Anson in the same locality. The spines number 11, and are followed by 8 soft rays. The coloration does not differ from that of the adult.

**POLYPTERUS WEEKSI** Blgr. (Plate X. fig. 3.)

The type on which this species was established in 1898 is a young specimen, 170 millim. long, with external gills measuring 15 millim., obtained at Monseme, Upper Congo, by the Rev. J. H. Weeks, from whom the British Museum has since received a specimen 380 millim. long and without external gills, obtained at the same locality. The young specimen, which is here figured, is in what I have defined above as the third period. It is dark olive above, yellow beneath, the two colours sharply delimited on the side; six narrow black bars across the back, with some black spots between them, the last followed by irregular marblings; a large black spot on the membrane to each dorsal spine; soft fins with dark and light spots; pectoral with three blackish cross-bands. I have already observed that the asperities on the scales, which are so striking in the young, disappear in the adult.

**POLYPTERUS SENEGALUS** Cuv. (Plate XI. fig. 3.)

This species differs from all its congeners in being of a uniform greyish olive, without any markings, at least in specimens above 120 millim. total length; but the very young, with which we have only quite recently become acquainted, are striped, as described hereafter. The external gills appear to be lost very early; for they have not yet been found in any specimen above 90 millim., although a large number of young have been examined by Steindachner, Budgett, and myself.

Two small specimens, measuring 60 and 69 millim. respectively, were obtained by Mr. Loat in the White Nile, at the mouth of Lake No, in the beginning of February 1901. In both, the external gills are present and measure 5 millim. The smaller specimen has 8 spines and 8 soft rays to the dorsal, the larger

9 spines and 7 soft rays; in both the 5 anterior spines are not fully formed, not bicuspid, whilst the others have already assumed their definite shape; the caudal fin is long, with the median rays produced, a little longer than the head; the scales are imbricate and rhomboidal, striated, except on the central areola. A dark brown band on each side, from the end of the snout, through the eye and over the external gill, to the base of the caudal; another dark band, only a little narrower, below the first along the body, separated from it by a narrow yellowish streak. The very young of *P. senegalus* is therefore banded like that of *P. lapradii*, with this difference, that the lower band is broader in proportion to the upper.

Dr. Ansorge's Nigeria collection contains several young with external gills, obtained at Abo in October 1901; the length of these specimens varies between 39 and 105 millim. In the largest the external gill is present only on the left side and measures 9 millim.; the dorsal spines, 9 in number, are bicuspid, the scales are nearly smooth, and mere traces of the dark bands are visible: the other specimens agree entirely in their markings with those obtained by Mr. Loat in the White Nile, and show the complete passage from cycloidal to rhomboidal scales, and of simple dorsal rays to pinnules with spines, the posterior of the latter being developed first.

#### POLYPTERUS PALMAS Ayres. (Plate XI, fig. 4.)

This species is closely allied to *P. senegalus*, and in it also the external gills do not persist long. I have only observed them in one specimen 95 millim. long, where they measure 8 or 9 millim.; in all other specimens examined, measuring 80 millim. and above, I have found them to be absent.

The body is brownish above, yellowish beneath; the upper parts are marked with darker cross-bars, close together, which branch off into marblings or a wide-meshed network on the sides, enclosing roundish yellowish spots; or the dark and light spots may be arranged in chess-board pattern on the sides; a blackish oval spot on the peduncle of the pectoral fin.

#### EXPLANATION OF THE PLATES.

##### PLATE X.

- Fig. 1. *Polypterus lapradii* Stdr., p. 123, young from Abo, S. Nigeria, slightly reduced.  
 2. Younger specimen of the same species, from Assay, S. Nigeria, nat. size, with (2 a) enlarged view of scales from the middle of the side.  
 3. *Polypterus weeksi* Blgr., p. 124, young from Monsembe, Congo, nat. size, with (3 a) enlarged view of scales from the middle of the side.

##### PLATE XI.

- Fig. 1. *Polypterus congicus* Blgr., p. 123, young, from Bangyville, Ubangi.  
 2. *Polypterus endlicheri* Heck., p. 124, young, from Abo, S. Nigeria.  
 3. *Polypterus senegalus* Cuv., p. 124, young, from Assay, S. Nigeria.  
 4. *Polypterus palmas* Ayres, p. 125, young, from Monsembe, Congo.

[All figures of the natural size.]



5. Description of a New Snake of the Genus *Psammodphis*,  
from Cape Colony. By G. A. BOULENGER, F.R.S.

[Received February 17, 1902.]

(Plate XII.)

*PSAMMODPHIS LEIGHTONI*. (Plate XII.)

Snout once and two thirds as long as the eye, with a shallow concavity in front of the vertex. Rostral a little broader than deep, visible from above; nostril between three shields; internasals shorter than the prefrontals; frontal twice as long as broad, in the middle about two thirds the width of the supraocular, as long as its distance from the end of the snout, slightly shorter than the parietals; loreal twice as long as deep; a single præocular, forming an extensive suture with the frontal; two postoculars; temporals 2+2; eight upper labials, third deeper than second and fourth, fourth and fifth entering the eye; four lower labials in contact with the anterior chin-shields, which are shorter than the posterior. Scales in 17 rows. Ventrals 156; anal divided; subcaudals 84. Dark brown above; the middle row of scales black with yellow shafts forming an interrupted light vertebral line; a yellow lateral streak along the adjacent halves of the third and fourth rows of scales; the upper half of the fourth scale black; scales of outer row yellow in front and brown or black behind; sides of neck with dark ocelli edged with bright yellow; head dark brown above, with a yellow line along the middle of the snout and another on each side of the frontal shield; two pairs of yellow spots on the parietal shields; four yellow bars on each side of the head, the first on the præocular, the second on the postoculars, the third extending to the upper surface of the head and nearly meeting its fellow on the occiput; rostral and labials yellow, with black spots; lower parts yellowish white, with black dots and two bluish-grey longitudinal lines which widen forwards into two bands and unite on the throat.

Total length 910 mm.; tail 270.

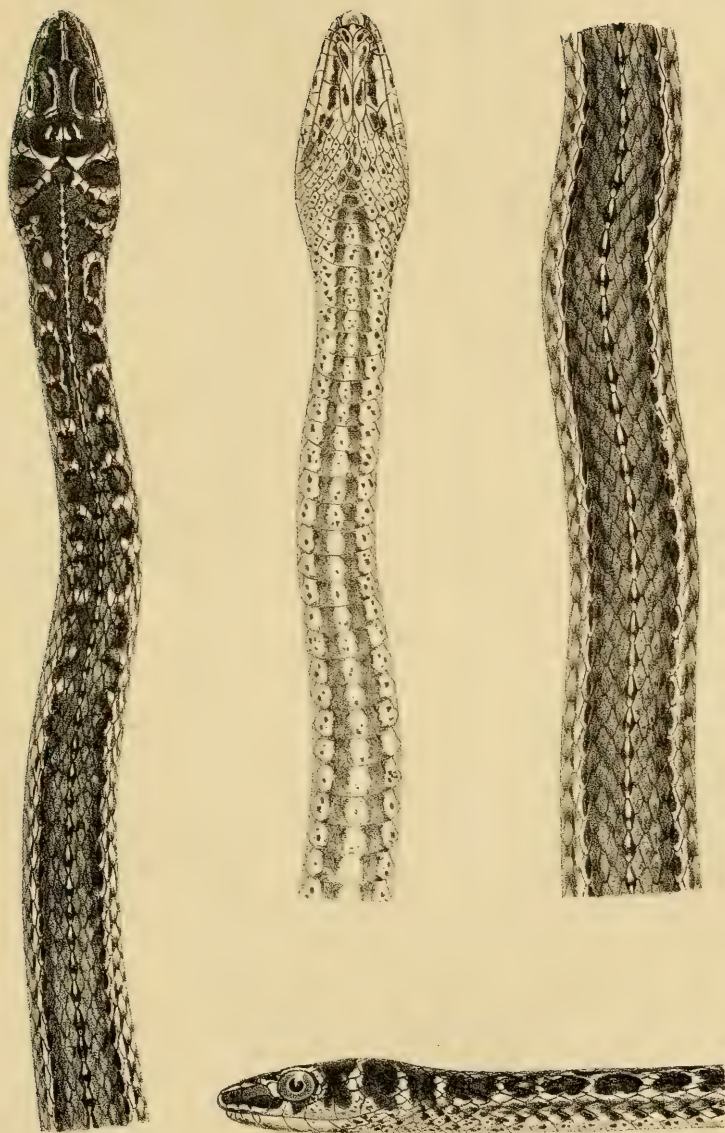
A single specimen, from Eerste River Station, 21 miles east of Cape Town, was received by Dr. G. Leighton, of Pontrilas, Hereford, and presented by him to the British Museum.

In its markings this Snake differs from all its congeners. It differs from *P. sibilans* in having the rostral shield broader than deep, as in *P. notostictus*, in which the præocular and the anal are divided.

EXPLANATION OF PLATE XII.

*Psammodphis leightoni*. Upper, lower, and side views of head and anterior part of body and upper view of middle part of body. Natural size.





P.J.Smit del.et lith.

Mintern Bros. imp.

PSAMMOPHIS LEIGHTONI.



6. Observations upon the Carpal Vibrissæ in Mammals. By  
FRANK E. BEDDARD, M.A., F.R.S., Vice-Secretary and  
Prosecutor of the Society.

[Received December 24, 1901.]

(Text-figures 17-21.)

In a brief note in 'Nature'<sup>1</sup>, and incidentally in a paper devoted to the anatomy of *Bassaricyon*<sup>2</sup>, I directed the attention of zoologists to a tuft of long and strong hairs which exist in many mammals on the wrist close to the root of the thumb and generally on that (the radial) side of the forearm. These long hairs are quite similar in character to those which are found in various parts of the head and face of many mammals, such as, for example, the "whiskers" of the domestic cat. They are readily seen on account of their size; and, as a rule, they are also conspicuous by reason of the fact that they are frequently, though not always, of a different colour from the hairs of the surrounding pelage. But if they escape the eye, as is sometimes the case in the skins of spirit-preserved specimens, they can be felt through the skin on account of the large hair-bulbs which receive the proximal ends of the hairs. That these structures must be of some use to their possessors seems to be obvious, and yet is not easy to prove. I have watched various animals, and cannot see that they make any use of the tuft of hairs upon the wrist for touching objects, except in the possible case of the Raccoon (*Procyon lotor*), which did appear to me to hold its food rather nearer to the wrist than is usual with animals. I believe that my two brief notes referred to are the first published statement of the *general* presence of this carpal tuft of hairs in mammals. Some years since, as I have already acknowledged, Mr. Bland Sutton described these hairs in various Lemurs<sup>3</sup>, and showed plainly that they are a general character of that group, though they were wanting (and I can here confirm Mr. Sutton) in the Potto. I find, however, that in every group of animals, with the exception of the Apes, which use their front limbs as grasping-organs as well as for locomotive purposes, these structures are present with some few, though rather striking, exceptions.

Since the publication of the facts contained in those two papers, I have had the opportunity of examining a large number of mammals belonging to various Orders. I am therefore now in a position to extend the statements which I originally made, and to give more in detail the distribution of these curious structures in the group of mammals. I do not think that we have here a secondary sexual character, though it is possible that in some

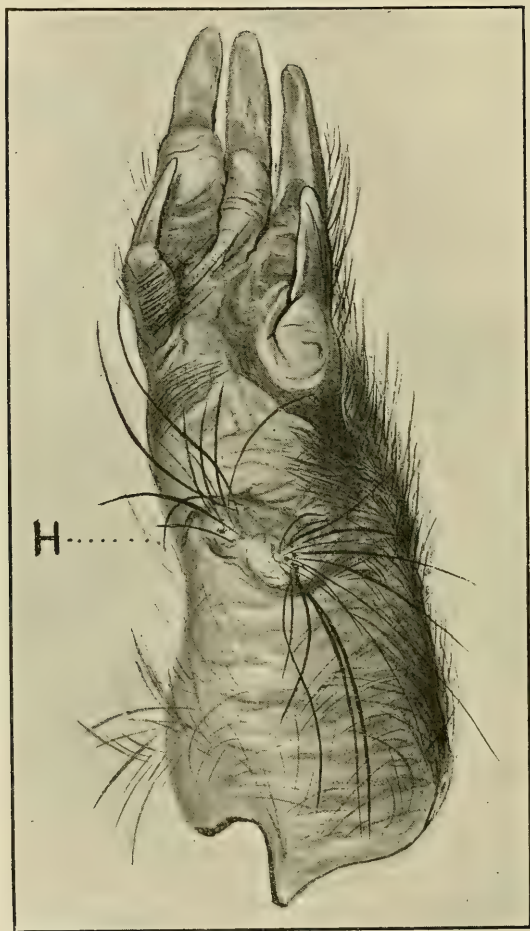
<sup>1</sup> Vol. lxii. p. 523.

<sup>2</sup> "On the Anatomy of *Bassaricyon*," P. Z. S. 1899, p. 661.

<sup>3</sup> "On the Arm-Gland of the Lemurs," P. Z. S. 1887, p. 369; where they are figured in the genera *Haplemur*, *Lemur*, and *Cheirogaleus*.

cases the male may be provided with the organ which is wanting in the female. I called the attention of the Society some little time since to the fact that the female of *Hapalemur simus*<sup>1</sup> has not this tuft, which is very plain and obvious in most Lemurs,

Text-fig. 17.



Left fore foot of *Dasypus villosus*; ventral surface.  
H, tuft of vibrissæ.

including the male of the closely allied *H. griseus*. I have, however, met with the structure in too many females of different species of mammals to allow of its being regarded as a sexual

<sup>1</sup> "Notes on the Broad-nosed Lemur, *Hapalemur simus*," P. Z. S. 1901, i. p. 121.

character. Broadly speaking, it may be stated that this sense-organ, as we may in the meantime assume it to be, characterizes the Lemurs, Rodents, Carnivora, and Marsupials, and that it is absent in the Ungulates (with the exception of *Hyrax*) and in the Primates (excluding the Lemurs). The Bats I have not yet studied from this point of view. Of the Insectivora I am unwilling to speak, as I have examined only *Centetes* and *Erinaceus*, which certainly had not this tuft of hairs.

As to the Edentata, the representative of this carpal tuft of vibrissæ does appear to exist at least in the Armadillo, *Dasyppus villosus*, as the accompanying figure shows (text-fig. 17, p. 128). But the hairs of that mammal are so coarse that there is but little difference in size and general appearance between the tuft which I compare to those of such an animal as *Petaurus sciureus* (text-fig. 18, p. 130) and the general hairs of the body. The Sloth (*Bradypus tridactylus*) has not any traces that I could discover of this "organ." As to other Edentates I have no information to offer, except concerning *Manis*, where I have found no traces of these hairs.

Considered broadly, therefore, this carpal tuft of vibrissæ is of some little use for classificatory purposes, apart from its absence in the Ungulates, where it might well be supposed to be deficient on account of the lack of facilities for use. The most salient feature as to its absence or presence is its nearly universal existence in the Lemurs, and the absolutely universal absence (as far as I have ascertained) in the Monkeys. These two divisions of the Primates, as they are most commonly considered to be, have been brought nearer to each other by recent researches upon certain extinct forms such as *Nesopithecus*<sup>1</sup>, and by investigations upon the placenta of *Tarsius*, which has been shown to be ape-like and even human in its characters<sup>2</sup>. It is not, therefore, without interest to be able to bring forward a character which seems to absolutely distinguish these two divisions of the Primates. Furthermore, it is not a character which has an obvious relation to ways of life: if the tuft of vibrissæ is useful to the Lemurs, it would seem to be equally useful to the Monkeys, many of whom use their hands as climbing- and grasping-organs in the same way. And I can at least assert, that while the majority of the Lemurs (excluding the Potto and the Loris) which I have examined possess this tuft, the large number of Monkeys, both of the Old and New Worlds, which have passed through my hands do not possess it.

As to the Marsupials, the genus *Macropus*, so far as my present investigations go, stands alone in that the wrist is not provided with this tuft of vibrissæ. I have examined both adults and quite newly born individuals of several species. In the naked new-born young of Marsupials this tuft of vibrissæ is exceedingly

<sup>1</sup> Forsyth Major, P. Z. S. 1899, p. 987.

<sup>2</sup> See, for a survey of the position of *Tarsius*, Earle, Amer. Naturalist, xxxi. p. 569.



obvious, and is nearly the only vestige of hair visible to the naked eye that the very young *Epiprymnus*, *Potorous*, and *Phalangista* possess. But this carpal sense-organ is by no means confined to the Diprotodontia. I have found it in *Perameles* and in the Rat-tailed Opossum (*Didelphys nudicaudata*).

The Carnivora as a group are apparently characterized by the existence of this organ. I have found it in representatives of the *Æluroidea* (Domestic Cat, Lion, *Cynictis levaillanti*, *Herpestes*

Text-fig. 18.



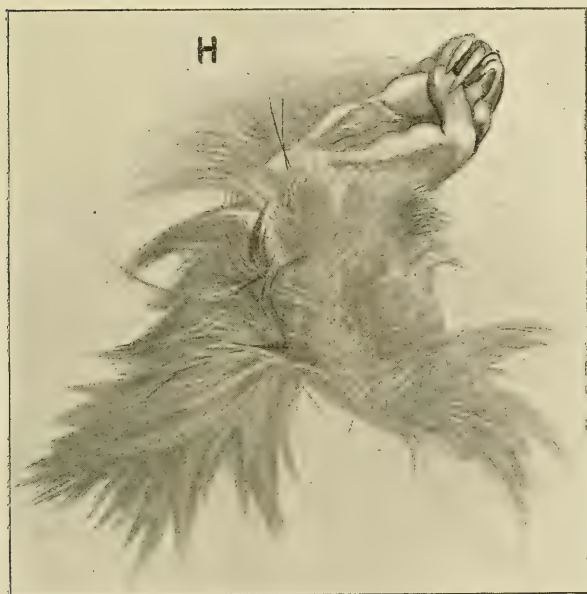
Right fore foot of *Petaurus sciureus*; ventral surface.  
H, tuft of vibrissæ.

*pulverulenta*), the Arctoidea (*Putorius*, Otter, *Mustela*, the Coati), but I do not find it in the Dogs. There are, however, apart from the Dogs, some exceptions to its occurrence in the Carnivora. It certainly does not exist either in *Viverra civetta* or in *V. tanga-lunga*. Oddly enough, I could not detect the tuft of hairs in the Tiger, obvious though they are in the Lion.

The Rodents again are, as a rule, to be characterized by the

possession of this tuft of vibrissæ. Its presence is not, however, universal in this order of mammals. On the whole, I should be disposed to think that those Rodents whose feet have more of an Ungulate character, such as the *Capybara* and *Dolichotis*, are without the structure in question; but the majority of the genera which I have examined certainly are furnished with these long vibrissæ. I have found them, for example, in several species of *Sciurus*, in *Cricetus*, *Gerbillus*, *Microtus*, *Saccostomus*, *Acomys*, *Mus*, and *Pteromys*. It is remarkable that though they exist in

Text-fig. 19.



Right hind foot of *Petaurus sciureus*; lateral surface.  
H, tuft of vibrissæ.

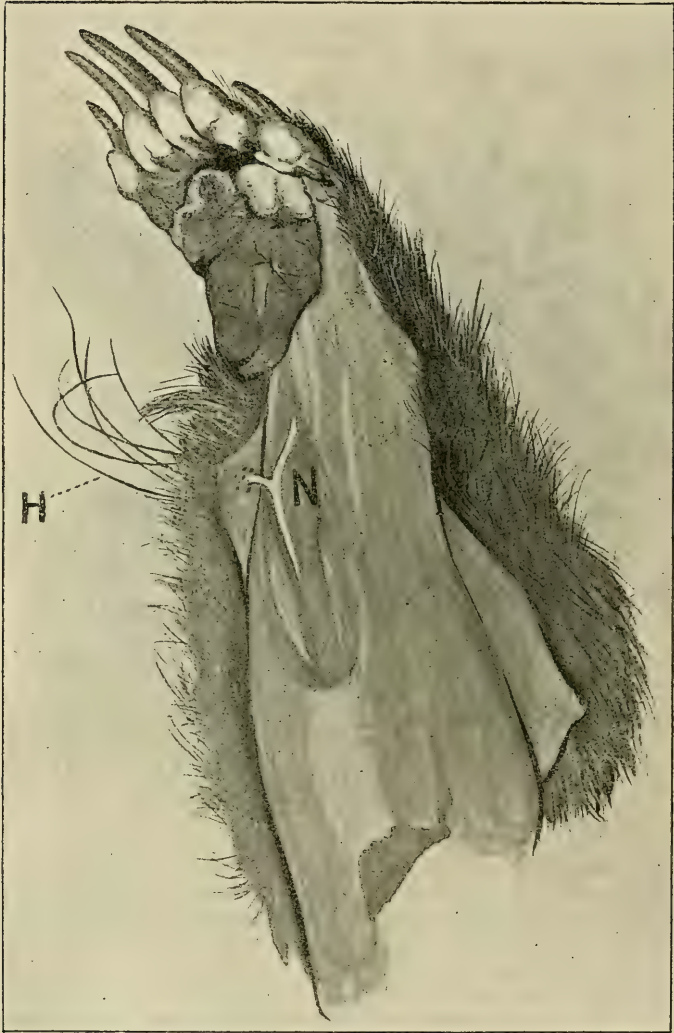
the Flying-Squirrel just mentioned, and I have had the opportunity of verifying their occurrence in two species, they are totally absent from the wrist of another genus of Flying-Squirrel, viz. *Sciuropterus*. Nor can I find the tuft in the Jerboa or in *Rhizomys*.

Another peculiarity of this tuft of specialized hairs is that it is not invariably to be found in all individuals of a given animal. As a rule, so far as my experience goes, it is the case that the tuft is constant and to both sexes. But in the Suricate I have found

the tuft absent in one example, a male, and present in a second of the sex of which I have no record.

In all the cases that have been referred to in the above brief

Text-fig. 20.



Left fore foot of *Nasua narica*; ventral surface.  
Dissected to show nerve (N) supplying tuft of vibrissae (H).

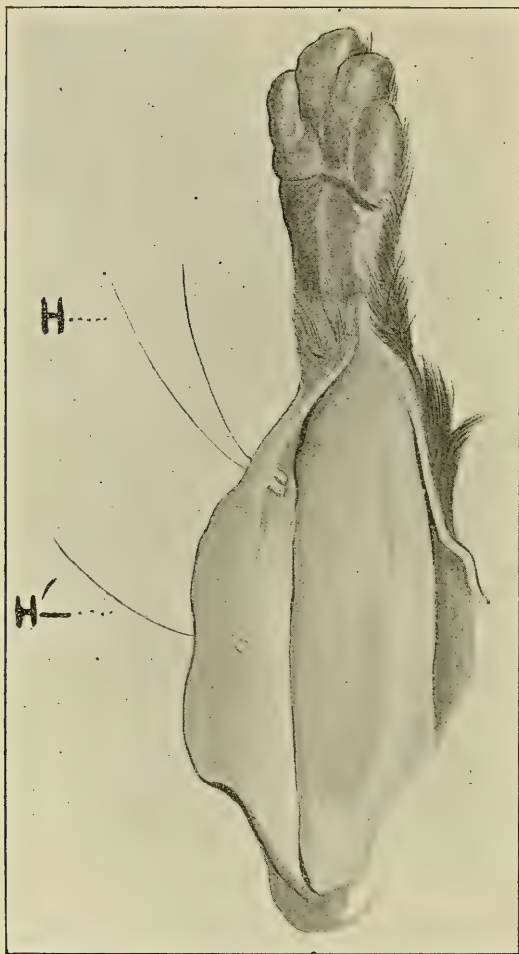
summary of the facts at my disposal, the vibrissæ were only to be found in the fore limbs. In some cases I admit I did not examine with great care the tarsus as well as the carpus. But after finding that in one species (illustrated in text-figs. 18, 19, pp. 130, 131) both fore and hind limbs showed a precisely similar tuft of vibrissæ, I naturally examined other animals that came my way. In *Petaurus sciureus*, in fact, this tuft of sensory hairs is present on both pairs of limbs, occupying a corresponding position in each. There was no difference that I could detect in the arrangement or structure of the vibrissæ in the two limbs. The case appears to me to be simply another instance of structures appearing in one pair of limbs being repeated in the other,—just as the horny spine-like outgrowths of the wrist of *Hapalemur griseus* are found on the ankle of *Galago garnetti*<sup>1</sup>.

The accompanying illustration (text-fig. 20, p. 132) shows the tuft of carpal vibrissæ in a Coati with the skin-flap removed and the muscles partly dissected. In this animal the tuft consists of six long black hairs, the implantation of which on the skin is shown in the drawing. The roots of these vibrissæ are provided with a nervous supply in the shape of a strong branch leaving the main nerve of the arm just opposite to the tuft, and ending after a short course without any sensible diminution of thickness and without any branching visible to the naked eye. This marked nervous supply to the carpal sense-organ is not, however, invariably found. The most aberrant condition of this carpal organ in all the animals which I have examined exists in *Hyrax*. In this Ungulate, the only Ungulate in which I have been able to detect the organ at all, I could only find it on one of the two fore limbs; and on that limb, the right, it was represented by only two long hairs, one being situated in the normal position which the tuft occupies in other mammals, and the other placed some way behind this. On carefully dissecting away the skin the roots of the hairs were exposed, and their great size enabled it to be seen that there were two of them, though only one hair was visible externally. In the case of the posterior tuft I could find but one hair-bulb. This state of affairs is shown in the drawing exhibited herewith (text-fig. 21, p. 134). The most careful examination failed to show any nerve-branch supplying the roots of the vibrissæ. I have no doubt that minute microscopic threads exist; but there is nothing that can be detected with the naked eye to be seen; and I think that it could hardly have been overlooked. Now it appears to me that we have in this animal a case of commencing retrogression of the organ in question. It can hardly be denied that *Hyrax* stands at least nearer to the base of the Ungulate series than do the Perissodactyla or the Artiodactyla. Therefore it is not surprising to find in *Hyrax* traces of a structure that has entirely disappeared in the more specialized forms; and in effect

<sup>1</sup> See Beddard, P. Z. S. 1884, p. 393, and *ibid.* 1901, vol. i. p. 272.

this appears to me to be the case. In *Hyrax* there is still a considerable trace of the carpal sense-organ, present (?) in the ancestral Ungulates, which had not completely left off the use of

Text-fig. 21.



Left fore foot of *Hyrax*; ventral surface.  
H anterior, H' posterior vibrissæ.

their fore limbs as grasping-organs; but it is evidently undergoing degeneration, and has finally disappeared in the newer forms of Ungulates. At least it has disappeared, so far as my



observations go, in the form which it possesses in the Carnivora, Marsupials, &c.

But I shall now proceed to urge some facts and suggestions which would tend to show that in the Horse tribe there are traces of this organ present in the well-known "chestnuts" of those animals—callosities on the fore and hind feet or fore feet only. And to do so I must revert to the Armadillo. The condition of this organ in the Armadillo requires some further description, as it differs in certain points from what is to be found in other mammals. As will be seen from the drawing (text-fig. 17, p. 128), the long vibrissæ are not so markedly longer than the hairs which clothe the skin generally as is the case with other mammals. The general hairy covering of the Armadillo is coarse. In the second place, they are decidedly more numerous and not arranged in a tuft; they do not, that is to say, apparently spring from the same circumscribed spot. On the contrary, they are borne upon a raised patch of integument which is about half an inch long; this tract of integument, moreover, is considerably thickened, which marks it off from the surrounding integument in a very distinct way. A dissection of the skin in this region shows a nerve supplying this tract of vibrissæ-covered skin; but the nerve is rather small in proportion to its bulk in such an animal as the Coati (text-fig. 20, p. 132). The tract of skin bearing the vibrissæ would be quite obvious if it bore no vibrissæ at all. It has, too, a hard "feel." Now if this specialization of the pad bearing the vibrissæ were to proceed further, it would become a mere horny pad and the vibrissæ would cease to grow upon its general surface, as with the pads of the foot. They would, so to speak, be driven off or at least to one corner. The resulting state of affairs would be such as is represented in the Lemur, where (*Lemur catta*) there is a horny pad, to the side of which is the tuft of carpal vibrissæ; a still further specialization would of course bring about the conditions which I and Mr. Sutton have shown to obtain in *Hapalemur griseus*. On the other hand, the disappearance of the tuft of vibrissæ would result in a structure precisely like the "chestnut" on the fore limbs of the Equidæ. It appears to me that the condition of the sensory organ upon the wrist of *Dasyppus villosus* distinctly suggests a possible origin for the "chestnuts" of the Horse tribe, which have been variously explained, but not in this way. There is every *a priori* likelihood of finding traces in the Ungulata of this widely spread organ, and, as already stated, in the primitive ungulate *Hyrax* they actually exist, in a but slightly modified form. The difficulty caused by the fact that the hind limbs in the true Horses have also "chestnuts" is removed by the occurrence in *Petaurus sciureus* of these organs on the hind as well as on the fore limbs<sup>1</sup>.

<sup>1</sup> It must be borne in mind, however, that in the horse the "chestnuts" of the hind limb are upon the ankle, those of the fore limb above the wrist. The latter position is that of other mammals.

It may be convenient to sum up the facts which have been detailed in this communication, and to present them in the form of a brief *résumé*:—

- (1) In nearly all the Orders of Mammalia—viz., the Primates, Carnivora, Ungulata, Rodentia, Edentata, and Marsupialia—there is generally a tuft of strong vibrissæ upon the wrist.
  - (2) This tuft consists of from one to about twenty hairs usually (if not always) supplied by a strong nerve which arises from the radial nerve of the arm.
  - (3) This structure is as a rule, when present, found in both sexes; but occasionally it is present in the male only.
  - (4) The tuft of carpal vibrissæ is apparently absent from all the Ungulates, except *Hyrax*; and from the Anthropeidea among the Primates.
  - (5) In the groups where the carpal organ is present, it is apt to be capricious in its distribution. Thus it is present in the Lion, and absent in the Tiger.
  - (6) With the marked exception of the Anthropeidea, there seems to be a certain relation between the presence of the tuft of carpal vibrissæ and the nature of the fore limbs. When the fore limbs are purely ambulatory limbs, the carpal vibrissæ are absent.
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March 4, 1902.

W. BATESON, Esq., F.R.S., Vice-President, in the Chair.

The Secretary read the following report on the additions to the Society's Menagerie during the month of February 1902:—

The registered additions to the Society's Menagerie during the month of February 1902 were 73 in number. Of these 24 were acquired by presentation and 49 were received on deposit. The total number of departures during the same period, by death and removals, was 154.

Amongst the additions attention may be specially directed to:—

(1) A young male Snow-Leopard (*Felis uncia*), from Ladakh, presented by Capt. H. I. Nicholl, of the 1st Bedfordshire Regiment, Mooltan. We are much indebted to Capt. Nicholl for the care and trouble which he has taken in sending us home this rare and beautiful animal, of which so few specimens have ever reached us, and to Messrs. Gellatly, Hankey, & Co. for its passage home in the s.s. 'Prome.' It was originally obtained by Capt. Nicholl in Ladakh about September 1901<sup>1</sup>.

(2) A pair of Prjevalsky's Wild Horses (*Equus prjevalskii*), being part of the same convoy as those lately acquired by His Grace The Duke of Bedford, our President, as was recently announced (see P. Z. S. 1901, vol. ii. p. 505).

Mr. Hagenbeck has supplied me with the following information respecting the capture of these animals:—

The Wild Horses were captured in three different districts in the vicinity of Kobdo in Western Mongolia (in about 38° N. and 90° 35' E.), in the Chinese Empire, as shown on the map which I now send.

From Kobdo the horses were taken to the Siberian Railway Station, Ob. They were thirty-nine days on the way, including four days of travel by barges on the River Ob.

The Prjevalsky's Horses drop their young ones from the latter days of April to about the 20th of May, and during this time they come to particular spots, which are marked on the map, and they find at these places plenty of food and water.

The system of catching them is the following:—Large troops of Mongols hunt in combination, waiting for the animals behind the hills, and when they observe that a great many are together they all, on a signal, suddenly start and ride after the animals. As the young ones cannot follow their mothers, they are caught with nooses that are arranged on long sticks. The captives are brought to the camp, where the Mongols keep a lot of common mares with their young ones. These young ones are then taken away, and the wild colts put to the common Mongol horses to be nursed by them. After a few days the young ones become

<sup>1</sup> See 'The Field' of 1902 (vol. xcix. p. 325) for an account of the capture of this animal.

well acquainted with their nurses and then follow easily up to Kobdo.

I exhibit a water-colour drawing (Plate XIII.) by Mr. Smit, taken from two of the specimens now in the Gardens, which gives a good idea of the general appearance of Prjevalsky's Horse in its winter dress.

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Mr. B. Tegetmeier, F.Z.S., exhibited a series of photographs of Prjevalsky's Horse, taken on different occasions, and stated that further information on the subject would be found in 'The Field' of January 11th (vol. xcix. p. 69, 1902).

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Mr. E. N. Buxton, F.Z.S., exhibited a series of photographic slides illustrative of bird- and animal-life on the White Nile, which he had lately visited. He called attention to the enormous abundance of aquatic birds and waders which resort to the mud-banks of the Nile south of Khartoum and to the numerous lagoons in the marshes in the neighbourhood of Fashoda. Portraits were shown of Pelicans, Sacred Ibises (worshipped by the Egyptians of the early dynasties, but not now found in Lower Egypt), and many other birds—such as White Ibises, Black Ibises, Buff-backed Herons, Jabirus, Cranes, Stilts, Fish-Eagles, Goliath Herons, and Marabouts. These had been secured by the use of a telephone-lens (by Dallmeyer), as also portraits of the Water-buck, the White-eared Cob (*Cobus leucotis*), the Tiang (*Damaliscus tiang*), and the Hippopotamus. The difficulties of making an approach to these wild animals for photographic purposes were described. Some characteristics of the Roan Antelope (*Hippotragus leucophaeus*) were pointed out, and the habits of the Buffalo of the Nile and of the Reed-buck (*Cervicapra bohor*) were explained. Mr. Buxton expressed the opinion that the habit of the natives of burning the grass on the marshes affected the coloration of the White-eared Cob. The variation in colour of individuals of this species was illustrated by two heads of old males, and a skin of another individual was exhibited showing a white spot on the withers resembling that found in Mrs. Gray's Water-buck (*Cobus maria*).

Pictures were also shown of village-life among the Dinkas—a race of remarkable stature which inhabit the southern part of the Ghezireh.

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Mr. G. T. Bethune-Baker, F.Z.S., presented a paper, entitled "A Revision of the Amblypodian Group of the Butterflies of the Family Lycenidæ," and made the following remarks:—

This important section of the Lycenidæ is broadly confined to the Indo-Malayan region, though a few species are found in China, Japan, and Queensland, and a few have also been recorded





P. J. Smit del. et lith.

EQUUS PRJEVALSKII.

Mintern Bros. imp.





from some of the Pacific Islands, such as New Britain and the Solomon group. The dominant section of the group is the genus *Arhopala*, which alone contains over two hundred species and varieties. Until the year 1890 these had generally been described under the genus *Amblypodia*, in spite of the fact that they are structurally quite distinct, and that Boisduval had created the genus *Arhopala*, and had been followed in its use by the brothers Felder in their important work in the 'Novara-Reise.' Boisduval, however, omitted to diagnose his genus; and it has only been since de Nicéville's third volume of the 'Butterflies of India' was published that the name has been generally used, but now most students of the Lycænidae adopt it. Mr. Moore has attempted to split it up into six different genera, viz., *Narathura*, *Nilasera*, *Panchala*, *Satadra*, *Darasana*, and *Acesina*; but none of the characters he gives are constant, and though the markings of *Acesina* are peculiar, yet the whole pattern follows precisely that obtaining in *Arhopala*, and structurally they are identical; so that under these circumstances I see no object in retaining that genus as distinct. The other genera also I am obliged to disregard, none of them having so good a *locus standi* as *Acesina*. The genus *Arhopala* forms one large homogeneous whole, and, with the exception of one or two extreme forms, the merest tyro would at once recognize them. I cannot therefore see what object is gained by endeavouring to split them up into several genera merely because of the large size of the genus. I retain Mr. Moore's genus *Mahathala*, which is very well marked; but, with all respect to that veteran observer, I cannot see my way to accepting the other six.

I divide the whole group into six genera, viz., *Amblypodia* Horsf., *Traota* Moore, *Surendra* Moore, *Thaduka* Moore, *Mahathala* Moore, and *Arhopala* Boisduval. These Butterflies are very sluggish in their habits, seldom flying unless disturbed, and then only for a short distance, settling again as soon as possible on the underside of the leaves, with which they assimilate well. They prefer the thick forests, and but little is known of their life-histories, though some of the eggs have been described by Doherty and one or two other observers. Distant remarked on the shade of blue varying considerably "*inter se*" at times; and this I have found to be the case, though I am unable to offer any real explanation. I believe it will be found to be owing to some chemical change, for it happens with apparently quite fresh specimens. The colours of the whole group are aniline: in the majority of the species they could not be made up, I believe, from the colours of the spectrum, and it is therefore possible that they may be more liable to change than otherwise.

In a dominant genus such as this is, we might look for certain forms to be highly specialized in some way or other; and we find that this is so, for we have a small number of species of that brilliant metallic lustrous green colour that is so prominent a feature in the Chinese and Japanese sections of the *Thecline*.

In one genus all the females are blue, thus proving that this beautiful green development is probably of a comparatively recent date. M. de Nicéville tells us that when seen in sunlight these green specimens are gems of beauty, compared with which the most brilliant of the blue species are absolutely dull.

Among many entomologists who have been most kind in lending me their insects, I must mention two in particular who have passed to the great majority. The late Dr. Staudinger sent me over a considerable portion of his collection of this group, including all his types; whilst the late M. de Nicéville (in whom India has lost a most energetic and untiring observer) was good enough to lend me the whole of this portion of his collection; so that these two gentlemen alone furnished me with well over two thousand specimens. My warm thanks are due not only to these but to many others for much kind help.

This Memoir will be printed entire in the Society's 'Transactions.'

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The following papers were read:—

### 1. On the Origin of Pearls.

By H. LYSTER JAMESON, M.A., Ph.D.

[Received February 7, 1902.]

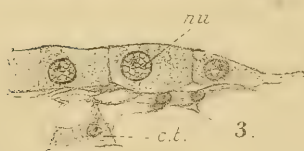
(Plates XIV.–XVII.<sup>1</sup> and Text-figures 22–24.)

Most theories of Pearl-production have assumed that the "nucleus," whatever its origin may be, is the direct cause of the secretion of a true pearl, and that the latter arises as a result of the mollusc's endeavour to coat with carbonate of lime an irritating body.

I do not propose in this paper to give yet another complete historical survey of the various hypotheses, dating back to the time of Pliny, which have been propounded. These theories have been summarized over and over again by writers on pearl-formation. The more recent ones may conveniently be grouped under the following heads:—That pearls are (1) concretions of shell-forming fluid (Réaumur, 1717); (2) shell-substance deposited around bodies or concretions of internal origin (Küchenmeister, in part, 1856; von Hessling, 1858; Pagenstecher, 1858); (3) formed around an abortive or displaced ovum (Home, 1826; Kelaart, in part, 1857); (4) secreted to coat over a grain of sand; (5) the result of injury to or perforation of the shell; (6) caused by a parasite (Filippi and others); (7) formed in an ampulla in the tissues (Hessling, 1858; Diguët, 1899). Several writers have allowed the possibility of two or more of these causes.

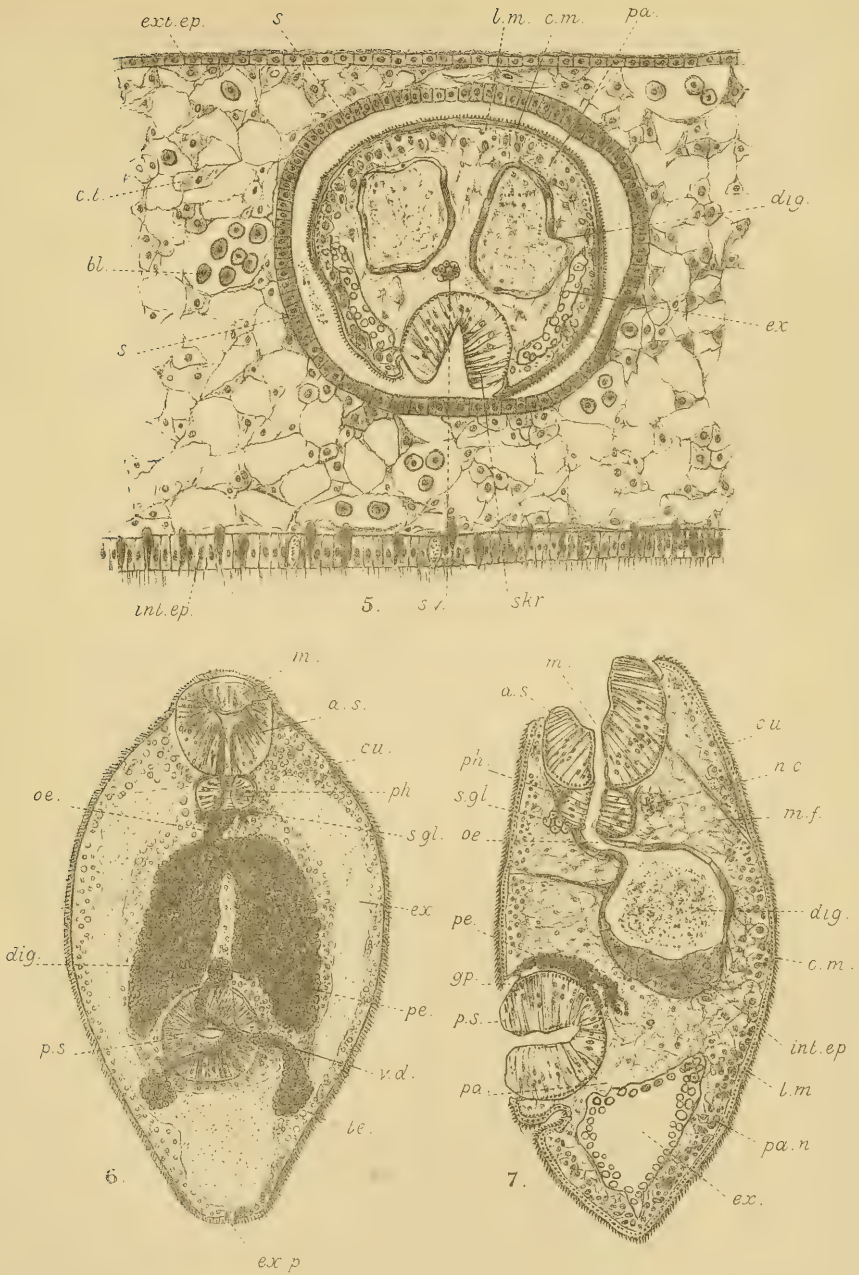
The origin of the "grain-of-sand" theory is veiled in obscurity.

<sup>1</sup> For explanation of the Plates, see p. 165.

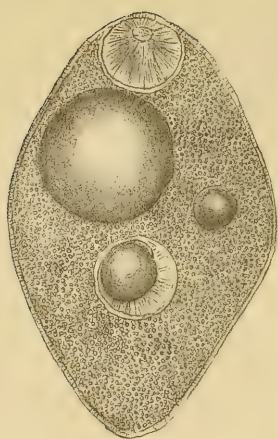




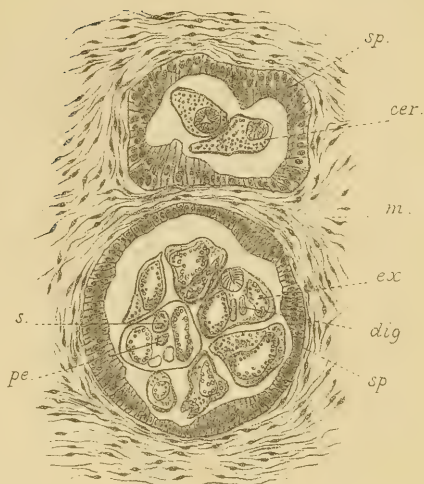




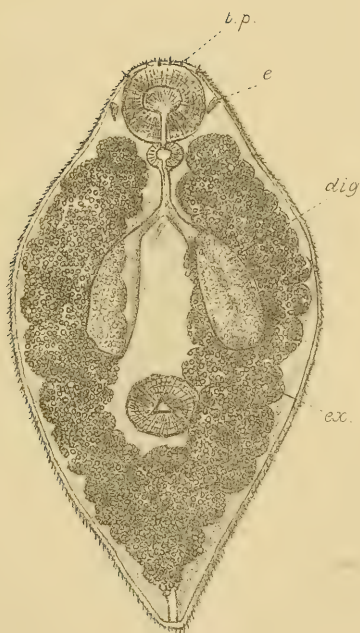




8.



9.



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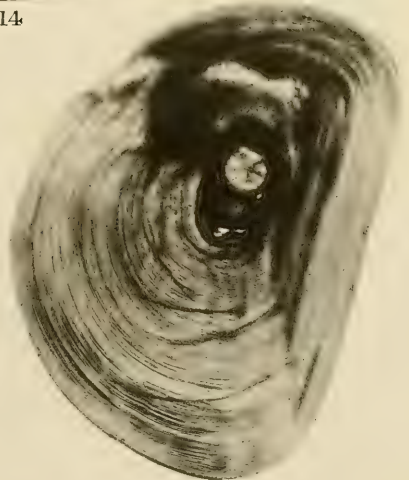
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Bemrose & Sons, Ltd, Collo.

JAMESON ON THE ORIGIN OF PEARLS.





It has had many supporters, and still maintains a prominent position in zoological text-books and popular compilations. It is doubtless largely due to a confusion of true pearls with "blisters" or pearly excrescences on the shell. There is no recorded instance of an undoubted sand-grain having been found in a pearl, although hundreds have been examined. All attempts to produce pearls by introducing such bodies into the tissues or between the shell and mantle have led, at best, only to the formation of "blisters." Such methods of obtaining the latter have long been known to the Chinese, and have repeatedly been applied in other countries. Chemnitz, Beckmann, and others (1791) regarded Linnæus's "secret process" as merely boring the shells. However, no subsequent boring experiments have yielded anything but blisters, and the popular notion of Linnæus's *modus operandi* is little more than a guess. A great step in the right direction was made when Filippi, in 1852, discovered the connection between pearls and the presence of *Distomum duplicatum* in *Anodonta*. Filippi regarded these Trematodes as encysted. In his later papers he allowed other forms such as *Atax ypsilophorus* to be occasional causes of pearl-formation. He recognized that the action of these parasites was specific, and compared it to the formation of plant-galls. Küchenmeister (1856) associated pearls in *Margaritana margaritifera* with the larvæ of *Atax ypsilophorus* van Beneden, which occur in the mantle, enclosed in cysts secreted by the mollusc. He held that other parasites, as well as bodies of internal origin, might also cause pearls.

Möbius (1857) found Trematode remains in pearls from the Pearl-Oyster of the West Coast of America (probably *Margaritifera margaritifera* L., var. *mazatlanica* Hanley<sup>1</sup>). Kelaart (1859) held that parasites played an important part in pearl-formation in *Margaritifera vulgaris* (Schumacher) in Ceylon, but did not associate any definite organism with it, although he found several species living in the Pearl-Oyster. Thurston (1894) confirmed the existence of platyhelminthan parasites in the same species, but did not assert that they had anything to do with pearl-production. Garner (1871) found that pearls in *Mytilus edulis* and *Margaritana margaritifera* were due to Distomids, against which the molluscs protected themselves by coating them with calcium-carbonate. Comba (1898), who claims to have discovered a method of producing free pearls by artificial means, says (p. 6) that the cause is "un parassito il quale viene dal mollusco avviluppato di strati di una bava che indurendosi forma la perla formando così una pustola ed una pallina che cresce in grossezza."

Dubois (1901) found in *Mytilus edulis* that the production of pearls was due to Distomid larvæ, to which (without description) he applied the name *Distomum margaritarum*. His account of the "*désagrégation*" of formed pearls, and the liberation, to repeat their life-cycle, of the parasites that form their nuclei, is quite at

<sup>1</sup> For revised nomenclature of the Pearl-Oysters, see Jameson, 1901.

variance with my experience; and apparently presupposes that the Trematode can survive complete calcification, which would indeed be a very remarkable biological phenomenon. According to Dubois it is only certain pearls that, by the death of the *Distomum*, escape this annual disintegration and so reach greater dimensions.

Von Hessling (1858), it seems, was the first to ascertain that the pearl is formed inside an epithelial sac, and he emphasized the importance of this structure. He regarded the sac as being derived from the blood-cells.

This sac has been noted by Diguët (1899), who suggests that it may be due to the stimulation of a parasite. I can find no support for Diguët's view, that the formation of the pearl in this sac proceeds on different lines to those on which the substance of the shell is deposited.

The "vesicle or bag of the ovum" figured by Home (1826, pl. xiii.) may also be this sac.

Before entering upon an account of my own observations, I wish to express my thanks to Mr. H. H. Arnold Bemrose for kindly preparing the microphotographs which accompany this paper; to Baron Louis d'Hamonville for much valuable information concerning the pearl-bearing mussels of Billiers; to Mr. A. Scott, of the Lancashire Sea-Fish Hatcheries, for supplying me with abundant material from the Piel mussel-beds; and to Mr. W. Wells, Marine Superintendent at the Brighton Aquarium, for conducting experiments for me.

The distribution of pearl-producing individuals of *Margaritifera margaritifera* L., *M. maxima* Jameson, *Pinnà nigrina* Lam., *Hippopus hippopus* L., and *Tridacna gigas* Lam., in New Guinea and Torres Straits, suggested to me that pearls were the result of a specific pathological condition, and that the circumstances necessary to ensure infection were present only in certain areas, often of small extent. I soon convinced myself, by a study of material that I brought home with me, that Trematodes formed the nuclei of some of the pearls in each of the above-named species, but that others contained nothing more than a few yellowish granules in the centre. The same results were obtained with specimens of *Mytilus edulis*, sent me from Lancashire by my friend Mr. James Johnstone. In all cases where the pearls had been preserved *in situ* in the tissues, they were found to be enclosed in a sac composed of an epithelium physiologically and histologically identical with the outer shell-secreting epidermis of the mantle. This observation at once accounted for the similarity in structure between the layers of the shell and those of which a pearl is composed. The obvious conclusion was that *this sac is the direct, and the Trematode the indirect, cause of pearl-production*, and that the key to the problem of the origin of pearls might be obtained by investigating the origin of the sac and its relations to the Trematode.

As it was not possible for me to return to the habitat of the true Pearl-Oysters, I selected the Common Mussel (*Mytilus edulis*) as a suitable species upon which to begin my observations. This mollusc produces pearls in many localities on the coasts of Europe, but it is only on certain beds that pearls are abundantly formed. The most favourable places seem to be estuaries or land-locked channels. In such situations pearls may be found in almost every example, except those which are attached to stakes or floating objects, and so raised off the bottom.

The pearls produced by the Common Mussel are, like the nacreous lining of the shell, lacking in lustre. They are generally white or silvery, but blue and brown examples are not uncommon. They have no value as gems, though, strange to say, a market seems to have existed for them in the first half of the last century ("D. C.," 1830).

They are mostly formed in the subcutaneous tissue of the dorsal body-wall or in the mantle-lobes. When they occupy a more deep-seated position they have probably been secondarily displaced.

In the little harbour of Billiers (Morbihan), situated on the estuary of the Villaine, there is a colony of pearl-bearing mussels, that has been described by d'Hamonville (1894). After reading d'Hamonville's account, I was struck with the idea that this colony should offer special facilities for investigating the causes of pearl-formation and the conditions for infection. D'Hamonville found that although the mussel is abundant all round the coast, pearls are only produced in the harbour itself, the beds being, at most, only a few acres in extent. Here almost every shell, if not too young, contains pearls.

I visited Billiers in August 1901 and again in December of the same year, and had no difficulty in finding the parasites and tracing the part played by them in pearl-formation. They were the larvæ of a Distomid belonging to the subgenus *Leucithodendrium* (Loos), and very closely resembling *L. somateriæ* (Levinsen), which in the mature condition inhabits the intestine of the Eider Duck. I found larvæ, very similar to these, in Sporocysts in *Tapes decussatus*, and subsequently proved the infection of *Mytilus* experimentally from these Sporocysts. In September of the same year I visited Piel, Lancashire, and found that there also pearls are caused by the same parasite, but that in this case *Cardium edule* acts as "first host" for the Sporocyst.

Finally, in December 1901, when I revisited Billiers, I examined five specimens of the Common Scoter or Black Duck, *Edemia nigra* L., which is notorious in the Villaine for its depredations on the mussel-beds, and is locally called, on account of its habit of feeding on *Mytilus*, "Cane moulière." Every one of these specimens was teeming with *Distomum* (*Leucithodendrium*) *somateriæ*.

For histological work, pearls were decalcified *in situ* in the tissues and then sectioned. Others were decalcified, cleaned, and

examined whole; while others again were ground down on a Water-of-Ayr hone, care being taken that the "Schliff" so made should pass as nearly as possible through the centre. The *Cercariae* and Sporocysts were either examined entire, or sectioned *in situ*.

For decalcifying, it was found best to use pearls preserved in spirit, as those that had been kept in a dry state, although often giving good results when examined entire in oil of cloves, were unfit for cutting with the microtome, owing to the brittle and horny nature of the dry conchyolin. The most satisfactory effects were obtained by using very dilute (.5 to 1 per cent.) nitric acid in water. Stronger solutions often caused bubbles of carbon dioxide to be evolved in the residual conchyolin, but by using these weak solutions freely the gas was dissolved almost as soon as formed. The time required for this process varied from a few days to some weeks, according to the dimensions of the pearl and the proportion of conchyolin to salts.

### *Structure of the Mantle and Shell.*

The tissues composing the mantle of *Mytilus edulis* are:—

- (1) An external simple epithelium, which is a direct continuation of the dorsal body-wall;
- (2) An internal ciliated epithelium, resembling the epidermis of the foot and gills; and
- (3) A spongy connective tissue; in the meshes of which the blood circulates.

The external epithelium (Pl. XIV. figs. 1–4, Pl. XV. fig. 5, *ext.ep.*, and text-fig. 22) is composed of a single layer of flattened columnar cells with spherical or ovate nuclei. The outer surfaces of these cells are closely applied to the inner nacreous substance of the shell. The appearance of this epidermis differs considerably according to the degree of contraction and method of preservation. Its constituent cells are polygonal in surface view, and brick-shaped or columnar in sections at right angles to the surface.

Their protoplasm stains rather more strongly with hæmatoxylin than that of the connective tissue, and shows faint striæ perpendicular to the surface. Their bases are attached to the connective-tissue fibres. Scattered here and there throughout this epithelium are spherical cells which stain lightly. They may be the "Eirund körnige Zellen" that Tullberg describes (1882). They are never numerous, and I am inclined to attribute their presence largely to defects in preservation.

The epidermal lining of the mantle-cavity (Pl. XIV. fig. 2, Pl. XV. fig. 5, and text-fig. 22, *int.ep.*) is the typical glandular ciliated epithelium so common in the skin of invertebrates. It is composed of columnar ciliated cells and interstitial gland-cells, some of which project basally into the connective tissue. It is



altogether a much more heterogeneous layer than that applied to the inner surface of the shell, and is usually rather thicker.

The connective tissue (Pl. XIV. figs. 1-4; Pl. XV. fig. 5, *c.t.*) is a meshwork of irregular or stellate cells with oval or spindle-shaped nuclei, and more delicate fibres the nuclei of which are relatively longer and narrower, and stain more deeply than those of the former. There is a perfect intergradation between the two kinds of cells, and their relative abundance varies in different individuals according to the condition of the gonads. The fibres are more numerous just under the epidermis than elsewhere. The blood circulates in the spaces between these cells and fibres, and in places these lacunæ are enlarged to form regular blood-sinuses. Numerous blood-corpuscles (*bl.*) can be seen in the meshes of the connective tissue, especially under the outer and inner epidermal layers.

Yellow refractive granular masses, showing traces of cellular structure, sometimes occur in the meshes of the mantle parenchyma, especially in old mussels. These may be the remains of the broken-down gonads of previous years, or groups of dead leucocytes.

In the connective tissue are embedded the nerves and muscle-fibres of the mantle, and the gonads when ripe extend into it.

The structure of the shell has been very thoroughly investigated by von Nathusius Königsborn (1877), Tullberg (1882), and Ehrenbaum (1885), to whose observations I can add nothing new.

The method in which the shell is laid down is of great interest on account of the identity in structure between the substance of pearls and that of the shell. Biedermann's recent paper (1901), which is full of new and significant facts and carefully summarizes previous observations, proves beyond all question that the organic basis of the shell (conchyolin), which is present also as the basis of pearls, is a true cuticular product, secreted or excreted by the underlying epidermis of the mantle. Biedermann shows that in both Lamellibranchs and Gastropods the calcareous substance of the shell *can only be deposited in such a cuticle*.

The cuticular conception of the conchyolin was, I believe, first propounded in this form by Huxley (1859). In sections of the decalcified shell and mantle, I find that the epithelium is generally applied closely to the conchyolin, and its cuticular outer surface is apparently directly continuous with the latter. If, during the process of fixing, the mantle has been separated from the shell, a certain amount of uncalcified conchyolin may be found attached to the epidermis. Moreover, if the mantle of a live mussel be carefully stripped from the inner surface of the shell, a delicate transparent membrane, like that which Huxley found in *Anodonta*, but less conspicuous, can be detected. This membrane tears away irregularly, some parts adhering to the mantle, others to the shell. This irregular tearing is a further evidence that the uncalcified membrane is in continuity with both shell and mantle. That the mantle can, however, detach itself from the inner surface of the

shell is obvious in such forms as *Margaritifera*, *Pinna*, and *Tridacna*, where the mantle-margin is freely retractile.

The evidence adduced in support of the alternate theory of growth by intussusception, originated by Mery (1712), revived by von Nathusius (1877 & 1898), and supported by Felix Müller (1885), is not convincing. The facts supposed to lend weight to this hypothesis are quite explicable on the apposition theory.

### *Pearls, Blisters, and Concretions.*

As some confusion exists as to the exact connotation of the word pearl, I propose to adopt in this paper the terms "pearl," "blister," and "free concretion" for three different kinds of structures that occur in molluscs.

*Pearls*.—A pearl consists of one or more layers of shell-substance (*i. e.*, conchyolin in which the crystals of inorganic matter are disposed in the same manner as in the shell), enclosing a central nucleus, and formed in a closed sac embedded in the tissues. This sac is composed of epithelial cells similar to those that form the outer mantle-epidermis. This sac is first formed around a parasite, which probably exercises a specific stimulation.

In *Mytilus edulis* and many other forms this parasite is a larval Trematode, but it is probable that certain other parasites can stimulate some molluscs to form such sacs. The parasite does not necessarily become the nucleus of the pearl, but may escape from the sac before calcification.

Any of the substances which form the different parts of the shell may be represented in a pearl. Thus we have nacreous pearls, prismatic pearls, the periostracum pearls of *Modiola modiolus* formed in the mantle-margin, pearls a part of which may be formed of the transparent striated substance which characterizes the attachment of the muscles to the shell, and pearls formed entirely or in part of the substance of the hinge-ligament. Large brown leathery hinge-pearls are occasionally found in Torres Straits in *Margaritifera maxima* Jameson.

A pearl may become secondarily fused to or embedded in the substance of the shell by the absorption of intervening tissues (text-fig. 22). These pearls are sometimes spoken of as attached pearls. Similarly two or more pearls may become fused together, forming double or compound pearls, of which a notable example is the celebrated "Southern Cross."

The various substances, when two or more are present, are not always arranged exactly in the reverse order of the layers of the shell, as sometimes stated. We may, indeed, have several alternations of nacre and prismatic substance, or of the latter and conchyolin. The kinds of shell-substance entering into the composition of a pearl are determined by the position of the latter. De Villepoix (1892) has shown that different parts of the mantle-epithelium are concerned severally in the formation of periostracum, prismatic and nacreous substance. Obviously the

epithelium of the pearl-sac acquires the special characters of the adjacent part of the epidermis.

*Blisters.*—It is proposed to confine this term to internal excrescences of the shell, which are caused by the intrusion of foreign bodies between the mantle and the shell, or by the secretion of a nacreous cicatrix to close the perforations of boring molluscs, worms, or sponges. These are sometimes referred to as “attached pearls” or even as “pearls,” but have a totally different mode of origin and should never be confused with the latter.

*Concretions.*—In many molluscs small free calcosphaeritic bodies occur at times in the connective tissues, which, not being enclosed in epidermal sacs, cannot acquire the structure of the shell-substance. They are probably due to different causes in different molluscs. In *Tapes* they are frequent, and are due to the calcification of degenerated Sporocysts or of dead Cercariæ contained in the same. Similar concretions, which I found in *Pholas candida* at Billiers, were caused by dead Cercariæ of another species, contained in Sporocysts.

Old examples of *Mytilus edulis* L., *Modiola modiolus* L., *Hippopus hippopus* L., *Margaritifera vulgaris* (Schumacher), and *Anodonta* sometimes contain similar bodies, but their origin in these cases is uncertain.

In all instances that have come under my notice they are more or less spherical, and composed of needle-like prisms of carbonate of lime radiating from a centre.

### *Structure of Pearls.*

A *Mytilus*-pearl examined entire often shows a darker spot in the centre, which corresponds to the “nucleus.” The nucleus is always visible in a section ground from the pearl, though its size varies from .1 mm. to .7 mm.

It is often yellowish brown or black, the colour being imparted by the dead remains of the Trematode, or by the small amount of residual matter left, if the worm has escaped from the sac (Pl. XVII. figs. 12–16). The crystalline structure of the nucleus is quite different to that of the remainder of the pearl and to that of the shell. We find in the nucleus one (Pl. XVII. fig. 16) or more (Pl. XVI. fig. 8, Pl. XVII. fig. 14) centres of calcification, consisting of spherical masses of radially arranged crystals. Each centre of calcification, if more than one be present in the nucleus, shows a distinct black cross when viewed between crossed nicols. Sometimes the nucleus is irregularly or incompletely calcified (Pl. XVII. figs. 14–16). The resemblance which concretions and the nuclei of pearls bear to *Harting's bodies* (Harting, 1872) is interesting; for they are formed, so far as we can judge, in a similar manner, namely, by the slow precipitation of carbonate of lime in a viscous substance like albumen or decaying animal matter. On the other hand, the peripheral parts of the

pearl are, like the shell, formed by the calcification of the cuticle of the living cells, and owe their structure to the special characters of that membrane or of the underlying epidermis.

A section of a decalcified pearl shows the nucleus, in which the cuticle and sometimes the suckers of the *Distomum* can be distinguished. Occasionally the outlines of the soft parts (*e. g.*, pharynx and digestive caeca) are still visible, as in Pl. XIV. fig. 1, *ph.* & *dig.* More generally, however, nothing can be seen but a mass of yellowish-brown granular substance surrounded by the cuticle (text-fig. 22).

There is often a certain amount of refractive granular matter associated with the remains of the worm, probably an excretion; and, if the parasite migrates out of the sac, this may form the inconspicuous nucleus of a pearl.

Just as the peripheral parts of a pearl present, when ground down to a thin section, a similar structure to that of the shell, so the conchyolin basis of a decalcified pearl shows the same characters. The outermost layer of the latter is uncalcified and continuous with the cuticle of the cells of the sac, just as the outer mantle-epidermis is attached to the inner surface of the shell (Pl. XIV. fig. 1, *con.*).

There is no organic union between the conchyolin and the nucleus.

The sac containing the pearl is composed of a simple columnar epithelium (Pl. XIV. fig. 1 & text-fig. 22, *s.*), which in its histological structure, as well as in its power of secreting as a cuticle the conchyolin basis of the pearl, is indistinguishable from the outer epidermis of the mantle.

Blood-spaces, containing corpuscles, are well developed around the sac.

Such a pearl cannot then be compared—as some writers have suggested—with the concretions or calculi of cholesterin or other substances found in the vertebrate body, but rather with the structures sometimes found in epidermoid tumours and atheroma cysts.

#### *Origin and Development of the Pearl.*

The Trematode enters *Mytilus edulis* as a tailless Cercaria, and at first may often be found between the mantle and shell. It is probable that it reaches this position by boring through the mantle, but I have not yet been able to find one in the act of doing so. The larvæ creep about on the inner surface of the shell, and, after a while, again enter the connective tissue of the mantle, where they come to rest, assuming a spherical form. They seem to avoid the more muscular parts of the mantle—no doubt because the absence of a definite boring apparatus makes it difficult for them to pass through the latter. When embedded in the tissues they are visible to the naked eye as little yellowish spots, about  $\frac{1}{2}$  mm. in diameter.

At first the worm only occupies a space lined by connective-



tissue fibrils (Pl. XIV. fig. 2), but soon the tissues of the host give rise to an epithelial layer, which lines the space and ultimately becomes the pearl-sac (Pl. XV. fig. 5, *s.*).

This epithelium appears to arise quite independently of the outer epidermis, and is no doubt due to a specific stimulation on the part of the parasite, as other parasites, *e. g.* Sporocysts, Cestode larvæ, &c., are not surrounded by such a sac.

At first a few cells appear (Pl. XIV. figs. 2, 3, *pr.*), which proliferate and arrange themselves along the walls of the cavity. These cells are larger than the connective-tissue corpuscles, and more susceptible to stains. They are flattened and polygonal in surface view. Their nuclei (Pl. XIV. fig. 3, *n.*) are large and spherical, and show the conspicuous chromatin reticulum and distinct nucleolus that characterize the nuclei of embryonic or rapidly dividing tissues.

I have not been able to find the nuclei of these cells actually undergoing division. The proliferating sheet of cells ultimately surrounds the parasite and becomes the sac. From the first these cells are basally continuous with fibres of connective tissue (Pl. XIV. fig. 3, *ct.*). Their transformation into the pearl-sac is a gradual one, and every step can be traced in sections of the parasites *in situ*.

If the Trematode larva completes its maximum possible term of life it dies, and the tissues of the body break down to form a structureless mass, which retains the form of the parasite owing to the rigid cuticle.

In this mass arise one or more centres of calcification (Pl. XVI. fig. 8), and the precipitation of carbonate of lime goes on until the whole larva is converted into a nodule which has the calcosphæritic structure already described for the nucleus. The granular matter surrounding the worm, if present, also undergoes calcification.

The epithelium of the sac then begins to shed a cuticle of conchyolin (Pl. XIV. fig. 1), and from this point the growth of the pearl probably takes place on the same lines and at the same rate as the thickening of the shell.

The sac sometimes begins to form pearly substance before the worm is completely calcified (Pl. XVII. fig. 16).

The Distomid larvæ sometimes leave the sac formed around them, and voluntarily migrate into other parts of the body before again settling down. Empty sacs may be found in the mantle, and old specimens of the larva (distinguishable from recently immigrated ones by their darker colour and laden excretory organs) sometimes occur free between the mantle and the shell.

The occurrence of pearls in which the nucleus is not a Trematode but merely a few refractive granules (Pl. XVII. fig. 13) can be accounted for in this manner.

Some compound pearls are evidently formed by short migrations on the part of the Cercariæ, which leave a small amount of



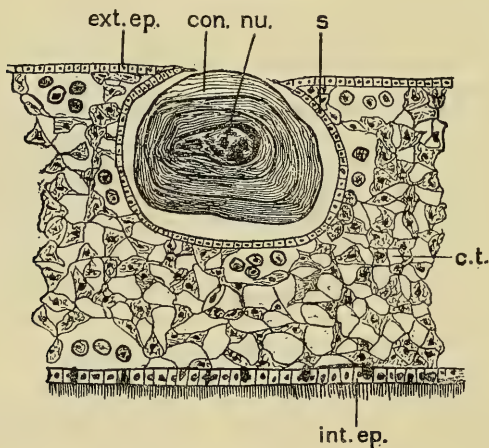
residual material in the sac, vacate it, and settle down in the immediate vicinity (Pl. XVII. fig. 15).

The residual matter in the first sac forms the nucleus of a pearl, and if the Trematode dies another is formed in the new one beside it. If these pearls grow and fuse a double pearl is formed, the nucleus of one half being obviously a Trematode, that of the other being merely granular matter.

I have traced three stages in the formation of such a pearl—the first, in which a Cercaria is found in a sac with a vacated sac close by; the second, in which a small pearl is close to the live Cercaria; and the third, in which two or more small pearls lie close together, only one having a Trematode for nucleus.

Dubois (1901) suggests that the death of the Distoma may sometimes be determined by Sporozoa, some members of which group are known to attack Trematodes. In one of the specimens that I sectioned there was a parasitic protozoon embedded in the tissues. If such parasites were to occur frequently they would of course facilitate and intensify the production of pearls. But they are not essential, any more than the presence of the dead Distoma in the sac is necessary for pearl-formation.

Text-fig. 22.



A Pearl about to become attached to the Shell.

*nu.*, nucleus of pearl; *int.ep.*, internal ciliated epidermis of mantle; *ext.ep.*, external epidermis of mantle; *con.*, conchyolin basis of pearl; *s.*, epithelium of pearl-sac; *c.t.*, connective tissue.  $\times 50$ .

A pearl may increase in size until its diameter is considerably greater than the thickness of the mantle, so that it protrudes visibly. It may even break through the ciliated epidermis; for valuable pearls have been found in the branchial chamber and also outside the shells.

If it presses upon the tissues intervening between itself and the shell, these may become absorbed, in which case the epithelium of the pearl-sac becomes continuous with the shell-forming epidermis (text-fig. 22). The result is that the subsequently formed layers of the pearl are continuous with those of the shell, and an attached pearl is formed. The fusion of two or more pearls to form a compound pearl is effected in the same way.

### *Structure of the Trematode Larva.*

With the exception of the female reproductive organs, which are as yet undeveloped, the larva presents all the characters of *Distomum* (*Brachycoelium* Dujardin, 1845, *Leucithodendrium* Loos, 1896) *somaterice* (Levinsen, 1882), from the Eider Duck, Greenland. (For sub-classification of Dujardin's subgenus *Brachycoelium*, see Stossich, 1899.) The body (Pl. XV. fig. 6) is oval, blunter in front than behind, and tapering markedly in the last third. In the resting condition inside the sac it is nearly spherical. The average dimensions are .55 mm. to .7 mm. The extreme sizes seen were .45 mm. and .75 mm. The oral sucker is larger than the ventral one, the ratio of their diameters being usually about 4 : 3. But in this point there is a considerable amount of variation both in the larva and in the adult *L. somaterice*. Except on the surfaces of the suckers, which are smooth, the cuticle is beset with small spines (text-fig. 23). These are arranged in transverse rows, the

Text-fig. 23.



Cuticle of the *Cercaria*, in surface view.  $\times 700$ .

members of which also form diagonal rows, so that the cuticle in surface view appears to be divided up into little diamond-shaped fields. There are about two hundred transverse rows of spines on the dorsum. Immediately around the ventral sucker the spines occur in concentric circles. The connective tissue is the typical parenchyma of the Flatworms (Pl. XIV. fig. 2; Pl. XV. figs. 5, 7, *pa.*). It is richer in nuclei immediately under the skin than elsewhere, especially on the dorsal surface (Pl. XV. fig. 7, *pa.n.*). Some muscle-fibres are present in the connective tissue running from the body-wall to the suckers and pharynx (Pl. XV. fig. 7, *m.f.*). The musculature of the body-wall consists of an outer circular layer (Pl. XV. figs. 5, 7, *c.m.*) immediately under

the cuticle, a deeper longitudinal layer (*l.m.*), and, on the ventral surface, a less defined tract of transverse fibres inside the longitudinal muscular coat.

The suckers are lodged in a slight involution of the cuticle (Pl. XV. figs. 5, 7). Their relative and absolute sizes in surface view are determined by the degree of contraction of their constituent fibres. The ventral sucker is about one-fourth or one-third of the total breadth of the body.

The mouth is situated in the middle of the anterior sucker, and generally appears triangular in sections (Pl. XV. figs. 6, 7, *m.*). The funnel-shaped buccal tube opens behind, by a narrow orifice, into the spherical muscular pharynx (*ph.*). This is followed by the short straight œsophagus (*œ.*), which, passing upwards and backwards, bifurcates to form the sac-like digestive cæca (Pl. XIV. fig. 2; Pl. XV. figs. 5-7, *dig.*), which are dorsal to the other organs. In the resting worm these cæca are greatly distended with yellowish granular material, doubtless derived from the tissues of *Mytilus*.

Even the œsophagus is often tightly crammed with food. The digestive system in this condition occupies the bulk of the body, anterior to the ventral sucker, but when empty is much smaller. The posterior end of the pharynx is provided with a group of salivary glands (Pl. XV. figs. 6, 7, *s.gl.*). The epithelium of the digestive system consists of very large flat polygonal cells with conspicuous nuclei (Pl. XV. fig. 7, *int.ep.*). The individual cells can sometimes be distinguished in pressure preparations. There is an ill-defined supra-pharyngeal nerve commissure (Pl. XV. fig. 7, *n.c.*) and a pair of lateral cords. The excretory system (Pl. XIV. fig. 2; Pl. XV. figs. 5-7, *ex.*) consists of two enormous tubular sacs, extending to the anterior end of the body and converging to form a pyriform median vesicle, which opens by a pore at the hinder end (Pl. XV. fig. 6, *ex.p.*). The excretory tubes are generally quite full of opaque spherical granules, presumably of excretory matter. When treated with hydrochloric acid they become transparent (Pl. XV. fig. 6).

In living specimens a few flame-cells can be seen in short, lateral, and apparently unbranched tubules given off by the excretory sacs. But the distended condition of the latter makes it difficult to ascertain their precise relations.

The female organs are not developed in the resting larva. The worm is protandrous, and the male genital organs reach a conspicuous size, even in the Sporocyst. The rudiments of the testes, vasa deferentia, and penis are very obvious in sections (Pl. XV. figs. 5, 7) and in stained preparations of the entire worm (Pl. XV. fig. 6). Being composed of young cells they stain deeply. In fresh specimens they are less obvious. The penis opens out at the genital pore (Pl. XV. fig. 7, *g.p.*), which is situated immediately in front of the anterior border of the ventral sucker. It is an elongated hollow pyriform body, lying in front of and dorsal to the sucker. The rudiment of the

seminal vesicle receives the vasa deferentia (Pl. XV. fig. 6, *v.d.*), which can be traced back into the spherical testes (*te.*).

### *Biology.*

When the larva first enters *Mytilus* it is somewhat smaller than the resting specimens and more transparent. The excretory organs, which are laden with granules while in the Sporocyst, are comparatively empty, and the gut is not yet distended with food. As it grows older both the excretory and digestive systems become more and more laden, so that they form the great mass of the body (Pl. XIV. fig. 2; Pl. XV. fig. 5). It is largely to the contents of the latter that the parasite owes its dark yellow colour, the cuticle being pale golden or straw-coloured.

The worm often excretes some granular substance, which may almost surround it in the sac. It is this stuff that serves as "nucleus" for a pearl, if the Trematode migrates to another part of its host.

It is interesting to note that at no period is this worm *encysted*, in the sense in which the Liver-fluke and so many other Cercariæ encyst. The dark colour of the epithelial sac, which can often be isolated with the worm, suggests, on casual observation, that the latter is encysted, but I have determined by sections that this is never the case.

In a certain sense it is a resting stage, but the distension of the alimentary system makes it obvious that it is also a highly assimilative phase in the life of the worm, which is storing up energy for the maturation of the gonads, on reaching the final host.

### *Life-history of the Parasite. The Sporocyst Stage.*

After a laborious examination of most of the organisms which inhabit Billiers Harbour, I was rewarded by finding, in *Tapes decussatus* Gmel., Sporocysts containing tailless larvæ, almost identical with those which occur in *Mytilus* (Pl. XVI. figs. 9, 10, and text-fig. 24). They differed from the latter only in their smaller size, paler colour, more distended excretory organs and empty gut, and in the possession of special sense-organs and eyes. *Tapes decussatus* is extremely abundant in Billiers Harbour, living in burrows about six inches deep in the black gravelly clay that forms the bottom. The local name of this mollusc is *Palourde*, and it is extensively collected for food. I am informed that although *Tapes* occurs in small numbers all along the shores of the Villaine, it is nowhere found in sufficient quantities to be worth fishing, except in Billiers Harbour. Indeed, when I visited Billiers in December 1901, a lugger from the other side of the estuary came over specially to collect this shell and *Mya arenaria* for the markets, there being no supply on the south shore.

I found Sporocysts in every specimen of *Tapes* that I examined, numbering nearly two hundred. They occur in the muscular or



connective tissue of the mantle-margin, where it is attached to the "pallial line," especially along the ventral border, and around the insertion of the siphonal musculature. The favourite place seems to be the dorsal side of the latter. The individual Sporocysts are embedded in and closely adherent to the bundles of muscle-fibres.

In young examples I found small, simple, spherical or oval Sporocysts, about .5 mm. in diameter, and containing 6-10 Cercariæ, but in larger examples groups of Sporocysts occur (Pl. XVI. fig. 9, and text-fig. 24).

Text-fig. 24.



*Tapes decussatus.*

Group of Secondary Sporocysts, as seen in a pressure preparation.

*m.t.*, muscular tissue of *Tapes*; *sp.c.*, Sporocyst; *cer.*, Cercaria contained in Sporocyst.

The individual Sporocysts in these cases are often larger than the simple ones. The groups are, from their position, their relations to one another, and their progressive increase in size and number of constituent cysts as *Tapes* grows older, evidently produced by budding or secondary division of the original simple ones. Their growth is very slow, and their duration of life must be practically co-extensive with that of their host. In large specimens of *Tapes* they appear to represent several successive infections; as we may have, in the same individual, large groups, probably several years old, smaller ones containing three or four cysts, and finally little single Sporocysts like those found in young individuals. On the other hand, in young *Tapes*, 10-20 mm. long, although the simple cysts and small groups occur, the large groups are not to be found.

Specimens of *Tapes* measuring  $12 \times 10$  mm., with one marked period or interruption in the growth-rings on the shell, contained



small simple Sporocysts, or, at most, groups of three or four secondary ones. Examples which averaged 17-21 mm. in length contained masses of seven to ten cysts, those measuring 27 mm. had still larger groups, while from that size upwards there was a steady progression in the dimensions and number of constituent units in the groups of Sporocysts. Some of those found in *Tapes* 40-50 mm. long measured 7 mm. in diameter, and contained as many as thirty secondary cysts, and a hundred Cercariæ or even more.

As the Sporocyst grows, it sometimes compresses the tissues that intervene between it and the shell, which apparently interferes with the secretion of fresh shell-layers. This leads to the development of white chalky spots on the inner surface of the valve. These patches, in old individuals, further prove that the large groups of Sporocysts are the descendants of the original small ones which are present when the molluscs are young. For we may see two or more white scars on the lining of the shell, marking the position of the cysts when the shell was younger. In fact, the Sporocysts may leave, imprinted on the shell, the history of their movements as the mantle-margin shifts outwards, just as the adductor muscles mark on the nacre the record of their migrations. The first or innermost of these scars is a small one, such as might result from a triple or quadruple cyst, the next is larger, while the group of Sporocysts in the mantle-margin is larger again. This plainly shows that as the mantle-margin followed the peripheral growth of the shell, the group of Sporocysts increased in size.

These compound Sporocysts are, of course, thicker than the normal thickness of the mantle, and stand out as opaque white granular eminences, obvious as soon as the shell is opened.

On the beds of Pearl-bearing Mussels in the Barrow Channel, opposite the Piel Fish-Hatchery, where every specimen of *Mytilus* is abundantly infected with the *Leucithodendrium*, and almost every specimen contains pearls, *Tapes* is not found. The Cockle, *Cardium edule* L., is common there, and acts as a host for the Sporocysts. Somewhat less than half the specimens of *Cardium* that I examined at Piel were infected. In *Cardium* the Sporocysts occurred in the mantle-margin, close to the anterior border of the anterior adductor muscle. Large groups, such as occur in *Tapes*, were not observed, but only single, triple, or quadruple cysts.

I have not yet been able to trace the infection of *Tapes* or *Cardium*. It is therefore impossible to say whether infection takes place by means of a free swimming *Miracidium* larva or not. The constant occurrence of the Sporocysts in exactly the same positions suggests that the eggs are carried into the digestive system of *Tapes* with the food-bearing current, hatch out in the alimentary canal, enter the circulatory system, and reach their destination *via* the posterior pallial artery, along the course of which they are distributed in *Tapes*. Moreover, the position in

which I found the Sporocysts in *Cardium* at Piel corresponds to the end of the anterior pallial artery.

The Cercaria in the Sporocyst first appears as a little oval cellular ball, budded off from the wall, measuring about .05 mm. During the early stages of its development it is transparent, and its structure can be made out without difficulty; but, as it grows, its excretory organs become gradually laden and distended with opaque granules, which conceal the other parts.

The fully formed Cercariæ in the Sporocysts measure .15 mm. to .3 mm. They are whiter than those found in *Mytilus*, but the arrangement of the spines on the cuticle is the same. They possess a pair of pyramidal or conical light brown eye-spots (Pl. XVI. fig. 10, *e.*), each provided with a lens. There are about six tactile papillæ (*t.p.*) at the anterior end of the body. These sense-organs are no doubt serviceable to the larva, during its free living stage, after leaving *Tapes*, and before entering *Mytilus*. The digestive system (Pl. XVI. figs. 9, 10, *dig.*) is empty, and occupies less space than in the *Mytilus* stage. The form and relations of the suckers and pharynx are the same. The penis (Pl. XVI. fig. 9, *pe.*) and testes are already developed, and have the same relations as in the *Mytilus* worm. In pressure preparations of the live worm they are not easy to discern.

The majority of Cercariæ in the Sporocysts are fully developed, young transparent ones being less common. They probably remain a considerable time before vacating it. A few on their way out may often be found free in the tissues of the mantle.

Search in the mud and with the tow-net at Billiers, failed to reveal the free living stage. I have, however, found examples in water in which *Tapes* had been kept for some days.

This Trematode is not provided with a cercarian tail at any stage of its existence, and it is only capable of creeping movements. The larva in the Sporocyst is rather more active than the later stage which occurs in *Mytilus*.

If a Cercaria dies while still in the Sporocyst, its remains become calcified; but, not being enclosed in an epidermal sac, secreted by the mollusc, it does not give rise to a pearl, but merely to a concretion. Again, an exhausted Sporocyst may undergo similar calcareous degeneration with the same result.

#### *Artificial Infection of Mytilus.*

On leaving Billiers in the beginning of September 1901, I brought with me about fifty infected examples of *Tapes*. I first placed these in a tank at the Piel Fish-Hatchery, which Professor Herdman and Mr. Scott kindly placed at my disposal. In order to test experimentally the infection of *Mytilus* from *Tapes*, I put in the same tank about seventy mussels, taken from the piles of the old pier at Piel. These mussels of which I examined a number, were practically without parasites. About one in every five of the largest examples contained a Cercaria, one had two

Cercariæ, and one contained a small pearl. It is apparently difficult for infection to take place, except on the bottom, owing to the absence of swimming-organs in the parasite. Hence the absence of Cercariæ in these examples.

Eleven days after they were placed in the tank I examined two of these *Mytili*, and found that the first contained one and the second two Cercariæ. These Cercariæ were recently immigrated examples, as they were small, rather transparent, and not yet surrounded by sacs.

I then transferred the experiment to Brighton, where Mr. W. Wells, the Marine Superintendent at the Aquarium, kindly kept the molluscs in a tank in his private office.

On the 18th of November, 1901, two months after the specimens were placed in this tank, I examined six of the mussels. Of these one contained six Cercariæ, another four, two had each three parasites, one contained two, and one was still uninfected.

When the experiment was transferred to Brighton I added about two dozen mussels that had been in the Brighton Aquarium for two years. I examined six such mussels before introducing the others, and found that none of them contained live Cercariæ, though four of them had one small pearl apiece.

On 5th April, 1902, I took up a sample of 10 mussels from this tank, comprising five of the specimens originally taken from the pier at Piel, and five of those that had been transferred from another tank at Brighton.

The following table suffices to show that in both cases infection had taken place:—

(a) Piel Pier mussels.

No. 1.	Contained 7 Cercariæ.
No. 2.	3 live and 2 dead Cercariæ, one of which was partly calcified.
No. 3.	2 live and 2 dead Cercariæ.
No. 4.	4 live Cercariæ.
No. 5.	2 live Cercariæ.

(b) Specimens transferred from other tank at Brighton.

No. 6.	Contained 19 Cercariæ.
No. 7.	3 Cercariæ.
No. 8.	2 Cercariæ.
No. 9.	1 (dead) Cercaria.
No. 10.	Still uninfected.

*The Adult Leucithodendrium.*

Although I have not had an opportunity of making a direct feeding experiment upon *Somateria* or *Edemia*, there is hardly any doubt that the parasite that causes the formation of the pearl-sac, and consequently of the pearl, in *Mytilus edulis* is the larva of *Leucithodendrium somateriae* (Levinsen), originally described from the Eider Duck (*Somateria mollissima* Linn.) in Greenland,

and rediscovered by me in the Scoter, *Edemia nigra* L., from Bridlington Bay and the Villaine Estuary.

After finding the Sporocyst I made a careful examination of such fishes and gulls as I could secure at Billiers, but could find no parasite corresponding to the larva. However, on enquiring of the fishermen I was informed that the great enemy of the mussel in those waters is a diving duck, locally called "Cane moulière," which frequents the Villaine in winter. M. d'Hamonville, to whom I wrote on the matter, had no hesitation in saying that this bird was *Edemia nigra*. On my visit to Billiers in December last I proved, by shooting an example and procuring four others that were taken in nets, that it was so. The name "Cane moulière" seems to be applied to another duck as well, probably the Scaup, *Fuligula marila* Linn. A few young Scoters remain on the Villaine during the summer months.

The Scoter is very common in winter at the mouth of the Barrow Channel, just opposite the pearl-bearing mussel-beds.

Before going to Billiers in December I had proved the occurrence of *L. somateriae* (Levinsen), associated with *Levinsenia pygmæum* Lev., in a specimen of *Edemia nigra* sent me from Bridlington by Mr. G. Williamson.

The Scoter received from Bridlington was in a rather advanced state, and I could only determine the presence of a few examples of *L. somateriae* in the hinder part of the small intestine. But the five specimens procured on the Villaine were infested with *L. somateriae* from the stomach to the anus and even in the caeca. I calculated that each specimen contained at least six thousand examples of the parasite. *Levinsenia pygmæum* Linn., which occurred abundantly in the Bridlington specimen, was not found at Billiers. The intestine of the Bridlington duck contained nothing but fragments of *Mytilus*-shells. The example which I shot at Billiers was feeding over mussel-beds, and the other four were caught in special nets which are placed on the beds of mussels at ebb tide, and in which the birds get entangled when they visit these beds with the flood, to feed.

These Billiers specimens had apparently been feeding exclusively on mussels, as no other food was found in them, except that one individual contained about half a dozen *Nucula* sp. and a broken *Littorina*-shell, in addition to *Mytilus*. In the crop and stomach some of the mussels were still entire, and specimens up to 40 millim. in length were found; in the stomach the shells are crushed, and pass through the intestine in small fragments at most a few millimetres in diameter.

The striking likeness, except for the matter of size, between the *Mytilus*-worm and *Leucithodendrium somateriae*, and the occurrence of the latter in the two birds that are known to feed *par excellence* on mussels, is almost sufficient to prove their identity without the feeding experiment. I hope, however, to make this experiment if birds can be secured. So far I have been unable to purchase live examples, although I have made enquiries



in all directions. My discovery in the small intestine of a Billiers Scoter, three inches behind Meckel's diverticulum, of a single immature example of the parasite, positively identical in size and all details with the *Cercaria* from *Mytilus*, practically proves the point.

The adults agree with Levinsen's description and figure, except that the genital pore (Pl. XVI. fig. 11, *g.p.*) is just in front, and not in the centre, of the ventral sucker.

Levinson's observation on this point has been treated with scepticism by later writers, and, indeed, such a position for the opening of the penis and other genital tubes would not only be a novelty in Trematode anatomy, but would probably render the sucker useless as an adhesive organ.

The adult worm varies in size from .2 mm. to .55 mm. It is therefore only about half the size of the larva found in *Mytilus*. It is protandrous, and specimens in which the male organs are ripe are generally larger than egg-laden females.

The diminution in size accompanying sexual maturation is of great interest, and can be accounted for in this way, I think. The resting-stage in *Mytilus* is a highly assimilative phase in the worm's existence. The bulk of the body is greatly increased by the distended gut and excretory system. A reduction in bulk would be effected by the discharge of the contents of the latter, but still more by the absorption of reserve material required to mature the gonads. In fact, the reproductive organs seem to grow at the expense of the other tissues of the body. The gut, I may mention, is empty in the adult worm.

Specimens from *Ædemia* die very quickly as a result of the *post-mortem* cooling of the body of their host. The Scoter that I shot was still warm when I dissected it, but the parasites died in a few minutes when placed on a slide, and an hour after the bird had been opened every adult worm was dead. The immature specimen above mentioned survived the death of the host by twelve hours. The temperature of the room where I worked at Billiers was very low, and possibly in a well-heated laboratory death would not ensue so quickly.

Owing to the rapid death of the worms, the material that I preserved was not suited for detailed histological work, but the relations of the various organs to one another could be determined on sections, and by this means I have been able to check my observations on pressure preparations of fresh material at Billiers.

Plate XVI. fig. 11 shows the structure of an average individual in which the maximum number of eggs has not yet been reached, and the uterus is not too complicated to mask the other structures.

The arrangement of the cuticular spines is the same as that described for the larva. The suckers and the digestive and excretory systems are also the same. The genital pore (*g.p.*) is just in front of the ventral sucker. The penis (*pe.*) is pyriform. Its extremity seems to be beset with glands. Posteriorly it goes over into the large sac-like seminal vesicle (*s.v.*). This lies dorsal to



and, as a rule, a little to the right of the sucker. At its hinder end it receives the vasa deferentia (*v.d.*). The testes (*te.*) are a little more conspicuous than in the larva. The uterus (*ut.*) opens out just in front of the penis. The arrangement of its convolutions depends upon the number of eggs contained (up to 100, or even more). It seems to begin on the left side, near the ovary (*ov.*), which is larger than the testes. It forms a series of convolutions on the left side, crosses in front of the genital opening to the right, where it forms further convolutions, passes forward as a loop to the anterior end of the body, and runs back to open out at the genital aperture. I am not convinced that this arrangement is always strictly adhered to.

The eggs in the uterus have the form depicted in my sketch and in Levinsen's figure. They measure from .018 mm. to .023 mm., the average dimensions being .021 mm. x .018 mm., but they differ considerably in different individuals. I can add nothing new to Levinsen's observations on the yolk-gland.

I sought in vain for this worm in *Bernicla brenta* Pall., *Tadorna cornuta* Gmel., *Querquedula crecca* Linn., *Colymbus arcticus* Linn., *Larus argentatus* Gmel., and *Rissa tridactyla* Linn. I have had no opportunity of examining other allied birds.

Being unable to secure live Eiders or Scoters, I tried feeding a male Pochard, *Fuligula ferina* Linn., with infected *Mytili*, but without results.

*L. somateriae* will very probably be found in the other members of the genera *Somateria* and *Oedemia* when looked for.

#### *The Conditions essential to Pearl-production.*

The characters and life-history of the parasite suffice to account for the anomalous distribution of pearl-bearing mussels, and, by analogy, throw light on the cause of the differences in the number of pearls produced by the true Pearl-Oysters on various pearling and shelling grounds.

In order to be abundantly infected *Mytilus* must be on the bottom, for the tailless Cercaria or "*Cercaricium*" is dependent upon its limited creeping powers, and the chance of being transported by currents and deposited with silt, &c.

Hence mussels grown on stakes, like those on Piel pier, although right in the middle of the beds of pearl-bearing individuals, are practically uninfected.

Secondly, there must be an abundance of the first host (*Tapes* at Billiers, *Cardium* at Piel) in the immediate vicinity of the mussels, in order to ensure frequent re-infection. For I find on the coasts of the Villaine, where *Tapes* is scarce, the proportion of infected *Mytili* is small. Moreover, on the Roosebeck Scar, outside the Barrow Channel, where *Cardium* is not found, pearls do not occur frequently.

Thirdly, the beds must be near the feeding-grounds of the

Scoter (or another final host), and the set of the currents must favour the transportation of the larvæ or eggs (whichever it may be) to the beds where *Tapes* occurs.

Although it is only on certain beds that these conditions exist, infection takes place to a small extent on very many beds. I have hardly ever examined a sample of mussels from any locality without finding here and there among them an infected individual.

*Duration of Life of the Larva in Mytilus, and Rate of Growth of Pearls.*

I am at present making experiments to test the longevity of the resting larva. I have, however, three facts to record that lead me to think it is less than two years.

While the mussels on the foreshore opposite Piel Fish-Hatchery are highly infected, those on the Roosebeck Scar, outside the Barrow Channel, are not so. When I was at Piel, Mr. Scott showed me a small patch of mussels on the pearl-bearing beds, and told me that these molluscs had been brought in from the Roosebeck by a fisherman about two years previously and thrown down there. I examined a number of these mussels, and each of them contained several small pearls. Some, indeed, had as many as ten, and all were infested with the Trematode. From the presence of pearls in these specimens, it is probable that the first Cercariæ to enter them had been dead some time. The dimensions of these pearls throw some light on the time required to produce pearls of a certain size. The five largest specimens weighed together 6.9 mg. (dried on filter-paper after being preserved in spirit), and measured respectively  $1.3 \times 1$  mm.,  $1.5 \times 1$  mm.,  $9 \times .85$  mm.,  $1.2 \times .8$  mm., and  $2.1 \times 1.15$  mm. The last was obviously, from its form, a double pearl.

Again, as four out of the six specimens that I dissected after they had been about two years in the Brighton Aquarium contained each a small pearl, but no live Trematodes, it is probable that the latter were unable to survive two years in the Aquarium.

Moreover, at Piel and Billiers pearls are very seldom found in mussels less than 40 mm. long, which size is probably attained when the mussel is in its third year. I find Cercariæ, on the other hand, in specimens only 20 mm. in diameter.

The average size of the larger pearls found in old mussels at Piel is about  $2 \times 2$  mm., but all sizes, from the dimensions of the parasite to  $3.35 \times 3.2$  mm., were found. At Billiers they are usually smaller, as the mussels are regularly fished there and seldom reach a great age. The pearl-bearing beds at Piel are not fished, as the infected mussels are not marketable.

The sizes to which pearls grow in other molluscs differ very greatly for the several species and for the same species in different localities. Their growth is, in fact, regulated by the causes which control the thickening of the shell. Hence the white porcellaneous pearls of *Tridacna gigas* and *Hippopus*

*hippopus*, in which species the shell is thick and massive, are often as large as a cherry. Among the true Pearl-Oysters the large thick-shelled species, *Margaritifera maxima* Jameson and *M. margaritifera* Linn., produce the largest pearls, those yielded by the smaller *M. vulgaris* (Schumacher) on the Ceylon fisheries and elsewhere being usually small, and prized rather for their colour and lustre than for their dimensions.

And it is interesting to note that *M. vulgaris* in the Persian Gulf, where it attains larger dimensions and yields a more massive shell than in Ceylon, gives on an average larger pearls than the Gulf of Manaar pearl-oyster.

The general experience of everybody acquainted with pearl-fisheries is that the largest pearls are found in the oldest and thickest shells, which proves how intimately the growth of pearl and shell are associated. It is natural that such an association should exist, since, as is obvious from the results recorded in this paper, the mechanisms of both processes are the same.

#### *Origin of Pearls in other Forms.*

Two questions will naturally occur:—Are we warranted in assuming that the mechanism of pearl-formation is the same in other molluscs? and, Is it generally caused by Trematode larvæ?

In answer to the first question, I may say that in those cases where I have been able to examine pearls *in situ*, in *Margaritifera margaritifera* Linn., *M. vulgaris* (Schumacher), *M. maxima* Jameson, *Hippopus hippopus* L., and *Pinna nigrina* Lam., this sac is universally present. It has been noticed by von Hessling in *Margaritana margaritifera*, and by Diguët in *Margaritifera margaritifera* L., from California. But, apart from this evidence, it is safe to say that without such an epithelial sac to shed the cuticular conchyolin, the nacreous layers of the pearl could not be laid down at all.

To what extent other causes besides Trematode larvæ may be capable of inducing such sacs to develop, has yet to be ascertained. Trematodes have been unquestionably associated with pearl-formation in *Anodonta*, *Margaritana margaritifera*, *Mytilus edulis*, and *Margaritifera* (?) *mazatlanica* (see Introduction).

Besides these records, I have detected the remains of Trematodes in decalcified or sectioned pearls from the following species:—*Margaritifera margaritifera* Linn., *M. maxima* Jameson, *M. vulgaris* Schumacher, *Pinna nigrina* Lam., *P. euglypta* Hanley, *P. virgata* Menke, *Hippopus hippopus* Linn., *Tridacna gigas* Lam., and *Mytilus magellanicus*.

I examined pearls from several other molluscs, but had not sufficient material to ascertain satisfactorily. In *M. vulgaris* Schumacher, besides the Trematode, there seems to be a second organism, possibly a Gregarine, concerned in pearl-formation.

The periostracum pearls in the mantle-margin of *Modiola* are also associated with parasitic protozoa.

These data suffice to show that in many molluscs, including several of the species yielding the most valuable pearls, Trematodes are one cause, if not the exclusive cause, of pearl-formation. To what extent other parasites are capable of producing the same effects cannot be said at present. That the other causes to which pearls have from time to time been attributed play any part is a matter of the merest conjecture only, and has never, so far as I know, been demonstrated by experiment or investigation.

*Possibilities of Economic Application.*

The bearing of the facts recorded in this paper upon the problem of artificially producing pearls, and so meeting the difficulty presented by the increasing demand and exhausted fisheries, is obvious. It was indeed with the hope of throwing some light on this matter that I first took up the subject, about three years ago. The key to the realizing of this, so often regarded as an academic dream, lies obviously in the scientific study of the parasites which occur in the valuable forms. This was pointed out exactly fifty years ago by Filippi, but has been ignored by most subsequent writers.

The life-history of the Trematodes occurring in the genus *Margaritifera* probably agrees in the more essential points with those of other Digenea. Their adult stages may reasonably be expected to occur in the organisms that eat the pearl-oysters, notably such fishes as *Balistes*, while the first host will almost certainly be some mollusc occurring on the pearl-banks or shelling-grounds.

Having ascertained the first host, there is no reason why infection should not be performed by placing young pearl-oysters in company with it in more easily accessible waters. To attempt to establish the cultivation of pearl-oysters on new grounds without also cultivating and infecting the first host of the parasite would be futile. Needless to say, such methods of artificially promoting natural infection would be incomparably superior to any method of pearl-production by *operation* on the individual oyster, as millions of examples could be treated by the former method, while tens were being operated upon.

It is obvious from my Brighton experiment that infection can be induced in *Mytilus*, and I can see no reason to doubt that, in a couple of years, these *Mytili* will contain pearls, resulting from that artificially induced pathological condition.

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## EXPLANATION OF THE PLATES.

## PLATE XIV.

*Mytilus edulis*.

- Fig. 1. *Mytilus edulis* L., Billiers. Section of a small Pearl, decalcified *in situ*, showing remains of Trematode as nucleus. *ext.ep.*, external epidermis of mantle; *ct.*, connective tissue; *bl.*, blood-corpuscles; *s.*, epithelium of pearl-sac; *con.*, conchyolin basis of pearl; *con.*, outermost uncalcified layer of same, attached to epithelium; *cu.*, cuticle of dead Trematode; *ph.*, pharynx, and *dig.*, digestive system of same.  $\times 90$ .
- Fig. 2. The Trematode larva in the connective tissue of the mantle, prior to formation of sac. *f.*, fibres of connective tissue; *pr.*, proliferating cells which give rise to the epithelial sac; *cu.*, cuticle; *dig.*, digestive caeca; *ex.*, excretory organs, and *pa.*, parenchyma of the parasite. Other figures as above.  $\times 130$ . The section passes between pharynx and ventral sucker. The ventral surface of the parasite is turned towards external epidermis.
- Fig. 3. The cells of the proliferating epithelium which is destined to become the sac (*cf.* fig. 12). *nu.*, nuclei with chromatine reticulum; *ct.*, connective tissue.
- Fig. 4. Cells of the fully-formed sac which surrounds the Cercaria in fig. 2. *ct.*, underlying connective-tissue cells and fibres.

## PLATE XV.

- Fig. 5. The sac fully developed around the larva, which is cut through ventral sucker. *s.v.*, rudimentary seminal vesicle at base of penis; *c.m.*, circular musculature; *l.m.*, longitudinal musculature; *skr.*, ventral sucker. Other letters as in previous figures.  $\times 130$ .
- Fig. 6. The Cercaria as it occurs in *Mytilus*. From a specimen stained *in toto*. *cu.*, cuticle; *m.*, mouth; *a.s.*, anterior sucker; *p.s.*, posterior sucker; *ph.*, pharynx; *s.gl.*, salivary glands; *æ.*, œsophagus; *dig.*, digestive cæca; *ex.*, excretory system; *ex.p.*, pore of same; *pe.*, penis; *te.*, testes; *v.d.*, vasa deferentia.  $\times 130$ .
- Fig. 7. The same, in longitudinal section. *pa.*, parenchyma; *pa.n.*, nucleated subcutaneous layer of same; *int.ep.*, intestinal epithelium, in surface view; *g.p.*, genital pore; *c.m.*, circular musculature; *l.m.*, longitudinal ditto. *m.f.*, muscle-fibre in parenchyma; *n.c.*, supra-œsophageal nerve-commissure. Other letters as in fig. 6.  $\times 130$ .

## PLATE XVI.

- Fig. 8. Dead Cercaria in *Mytilus*, with three centres of calcification.  $\times 130$ .
- Fig. 9. Section of the muscular mantle-margin of *Tapes*, showing the Sporocysts with contained Cercariæ. *m.*, musculature of *Tapes*; *sp.*, sporocyst; *cer.*, Cercaria; *ex.*, excretory tubes; *dig.*, digestive cæca; *pe.*, penis; *s.*, ventral sucker of same.
- Fig. 10. Pressure preparation of the Cercaria from Sporocyst in *Tapes*. The specimen was examined alive, so sexual organs are not visible. *e.*, eyes; *t.p.*, tactile papillæ; *dig.*, digestive cæca; *ex.*, excretory system.  $\times 700$ .
- Fig. 11. The adult worm from *Ædemia nigra* L., River Villaine. *s.v.*, seminal vesicle; *ov.*, ovary; *ut.*, uterus; *g.p.*, genital pore. Other letters as in fig. 6. Stained *in toto*.

## PLATE XVII.

- Fig. 12. *Mytilus edulis* L., Piel, Lancashire. Photo of a thin slice or "Schliff" through centre of pearl, showing calcified Trematode as nucleus.  $\times 25$ .
- Fig. 13. Ditto. Pearl formed in sac vacated by Trematode. A few granules of residual matter have calcified to form nucleus.  $\times 25$ .
- Fig. 14. Ditto, showing several centres of calcification in the Trematode.  $\times 25$ .
- Fig. 15. Ditto, double pearl, one of constituents being formed around Trematode, the other as in fig. 13.  $\times 25$ .
- Fig. 16. Pearl from *Margaritifera margaritifera* Linn., New Guinea, showing imperfectly calcified Trematode, with radially arranged prisms.  $\times 25$ .

## 2. List of the Parrots represented in the Society's Collection in January 1902, with Remarks on some of the Rarer Species. By P. L. SCLATER, D.Sc., F.R.S., Secretary to the Society.

[Received February 20, 1902.]

(Plates XVIII. & XIX.<sup>1</sup>)

The birds in the Society's Parrot-house having been lately re-arranged and the duplicates and "deposited" specimens having been moved to another place, I have thought it worth while to prepare a list of the species of Psittacidæ now represented in the Collection, which may be useful in future years, and to add to it a few notes on some of the rarer forms.

It may be observed that the 147 specimens of Parrots now

<sup>1</sup> For explanation of the Plates, see p. 171.



H. Goodchild del.

Mintern Bros. Chromo lith.

ECLECTUS WESTERMANNI, ♂, ♀.





J. Smit del. et lith.

Mintern Bros. Chromo.

PLATYCERCUS MASTERSIANUS.





living in the Parrot-house are referable to the following 107 species<sup>1</sup>, which are arranged and named according to the order followed in the first edition of the 'List of Vertebrated Animals, (1896).

#### LIST OF LIVING PARROTS, 1902.

##### Fam. NESTORIDÆ.

- \*1. *Nestor notabilis* Gould.

##### Fam. LORIIDÆ.

2. *Eos rubra* (Gm.).
3. — *riciniata* (Bechst.).
4. — *wallacii* (Finsch).
5. *Lorius domicella* (Linn.).
6. *Trichoglossus hamatodes* (Linn.).
7. — *forsteni* (Temm.).
8. — *novæ-hollandiæ* (Gm.).
- \*9. — *rubritorques*, Vig. & Horsf.
10. — *ornatus* (Linn.).
11. *Psitteuteles euteles* (Temm.).
12. *Glossopsittacus concinnus* (Shaw).

##### Fam. CACATUIDÆ.

##### Subfam. CACATUINÆ.

13. *Calyptorhynchus naso* Gould.
14. *Callocephalon galeatum* (Lath.).
15. *Cacatua galerita* (Lath.).
16. — *triton* Temm.
17. — *sulphurea* (Gm.).
18. — *leadbeateri* (Vig.).
19. — *moluccensis* (Gm.).
- \*20. — *gymnopsis* Scater.
21. — *sanguinea* Gould.
22. — *ducorspi* Hombr. et Jacq.
23. — *hæmaturopygia* (P. L. S. Müll.).
24. — *roseicapilla* Vieill.

##### Subfam. CALOPSITTACINÆ.

25. *Calopsittacus novæ-hollandiæ* (Gm.).

##### Fam. PSITTACIDÆ.

##### Subfam. CONURINÆ

26. *Anodorhynchus hyacinthinus* (Lath.).
27. — *glaucus* (Vieill.).
28. *Ara ararauna* (Linn.).

<sup>1</sup> In March 1879 there were 170 Parrots in the Society's Collection, referable to 98 species (see P. Z. S. 1879, p. 299).

29. *Ara macao* (Linn.).
30. — *chloroptera* Gray.
31. — *militaris* (Linn.).
32. — *severa* (Linn.).
33. — *maracana* (Vieill.).
34. *Conurus acuticaudatus* (Vieill.).
35. — *auricapillus* (Licht.).
36. — *nanday* (Desm.).
37. — *rubrolarvatus* Mass. et Souancé.
38. — *holochlorus* Sclater.
39. — *ocularis* Sclater & Salv.
40. — *cactorum* (Max.).
41. — *ceruginosus* (Linn.).
42. *Conuropsis carolinensis* (Linn.).
43. *Cyanolyseus patagonus* (Vieill.).
44. *Pyrrhura leucotis* (Licht.).
45. *Myopsittacus monachus* (Bodd.).
46. *Psittacula passerina* (Linn.).
47. *Brotoperys virescens* (Gm.).
48. — *pyrrhopterus* (Lath.).
49. — *tui* (Gm.).

## Subfam. PIONINÆ.

- \*50. *Chrysotis guildingi* (Vigors).
- \*51. — *augusta* (Vigors).
52. — *amazonica* (Linn.).
53. — *æstiva* (Linn.).
54. — *ochrocephala* (Gm.).
55. — *auripalliata* (Less.).
56. — *levaillanti* Gray.
57. — *viridigena* Cass.
58. — *salvini* Salvad.
59. — *autumnalis* (Linn.).
60. — *inornata* Salvad.
61. — *festiva* (Linn.).
- \*62. — *bouqueti* (Bechst.).
63. — *albifrons* (Sparrm.).
64. — *ventralis* (Müll.).
65. — *leucocephala* (Linn.).
66. — *agilis* (Linn.).
67. *Pionus maximiliani* (Kuhl).
68. — *chalcopterus* (Fraser).
69. *Caica melanocephala* (Linn.).
70. *Pæocephalus gulielmi* (Jard.).

## Subfam. PSITTACINÆ

- \*71. *Psittacus erithacus* Linn.
72. *Coracopsis vasa* (Linn.).
73. — *nigra* (Linn.).

## Subfam. PALÆORNITHINÆ.

- 74. *Electus pectoralis* (Müll.).
- \*75. — *westermanni* Bp.
- 76. — *cardinalis* (Bodd.).
- 77. *Tanygnathus luzonensis* (Linn.).
- 78. *Palceornis torquata* (Bodd.).
- 79. — *docilis* (Vieill.).
- 80. — *fasciata* (Müll.).
- 81. — *eupatria* (Linn.).
- 82. — *magnirostris* Ball.
- 83. — *derbianus* Fraser.
- 84. — *schisticeps* Hodgs.
- \*85. — *finschi* Hume.
- 86. *Polytelis barrabandi* (Swains.).
- 87. — *melanura* (Vig.).
- 88. *Ptistes erythropterus* (Gm.).
- 89. *Aprosmictus cyanopygius* (Vieill.).
- 90. *Pyrhulopsis splendens* (Peale).
- 91. *Loriculus galgulus* (Linn.).
- 92. — *vernalis* (Spartm.).

## Subfam. PLATYCERCINÆ.

- 93. *Platycercus elegans* (Gm.).
- 94. — *flaveolus* (Gould).
- \*95. — *mastersianus* Ramsay.
- 96. — *pallidiceps* Vig.
- 97. — *eximius* (Shaw).
- 98. — *barnardi* (Lath.).
- 99. — *browni* (Temm.).
- 100. — *semitorquatus* (Quoy et Gaim.).
- 101. — *zonarius* (Shaw).
- 102. *Psephotus multicolor* (Brown).
- 103. — *hæmatonotus* Gould.
- \*104. — *chryspterygius* Gould.
- 105. *Cyanorhamphus unicolor* (Vig.).
- 106. — *novæ-zealandiæ* (Gm.).
- 107. *Melopsittacus undulatus* (Shaw).

## 1. NESTOR NOTABILIS.

A pair of these birds were presented to us by the Hon. Walter Rothschild, F.Z.S., on Feb. 16th, 1899. They are fed upon ordinary food, and have no meat given to them, as was, at one time, thought to be necessary. They are in excellent health and condition.

## 9. TRICHOGLOSSUS RUBRITORQUES.

Of this beautiful Australian species the four examples, deposited by the Hon. W. Rothschild, F.Z.S., July 27th, 1900, are the first

and only specimens ever received by the Society. (See P. Z. S. 1900, p. 772.)

20. *CACATUA GYMNOPIA*.

This specimen is the oldest bird in the Parrot-house, having been in the Society's possession for 33 years. It was purchased June 2nd, 1868.

- |     |                              |   |
|-----|------------------------------|---|
| 50. | <i>CHRYSOTIS GUILDINGI</i> . | } |
| 51. | „ <i>AUGUSTA</i> .           |   |
| 62. | „ <i>BOUQUETI</i> .          |   |

We have always a good series of specimens of the Neotropical genus *Chrysotis* in the Collection. We are now so fortunate as to possess examples of these three rare Antillean species, and only a short time ago had also an example of *C. versicolor* of Dominica. (See P. Z. S. 1890, p. 772.)

71. *PSITTACUS ERITHACUS*.

One of our specimens of this bird (received Dec. 24th, 1897) has a pure white tail.

75. *ECLECTUS WESTERMANNI*. (Plate XVIII.)

In 1899 and 1900 we received under our care a series of ten specimens of both sexes of this bird, deposited by Mr. Rothschild. Whatever doubts may have been formerly expressed, it is now, I think, quite certain that this is a valid species, although we do not yet know its exact locality. Mr. Rothschild having already published his notes on this remarkable species (Bull. B. O. C. x. p. ii, Oct. 1899), I need not repeat them here further than to say that the male is at once recognizable by its entirely green breast, and that the female is most like the corresponding sex of *E. pectoralis* but has a dull purple (not blue) lower breast.

85. *PALEORNIS FINSCHI*.

This is a rare species from Burmah, of which we received our first specimen in Nov. 1901 from Mr. E. W. Harper, F.Z.S., to whom we are indebted for examples of so many rare Indian species. (See Cat. B. xx. p. 458, pl. xii.)

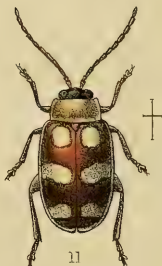
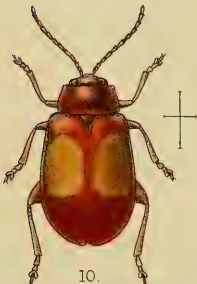
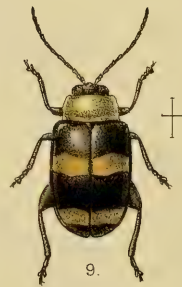
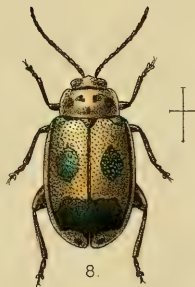
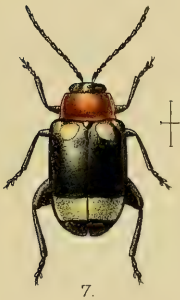
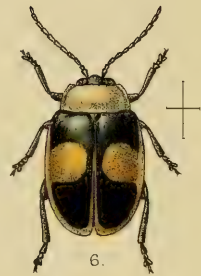
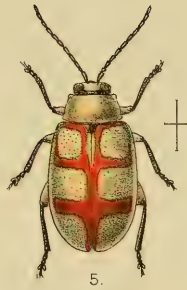
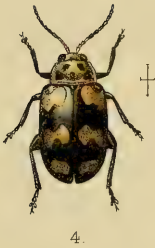
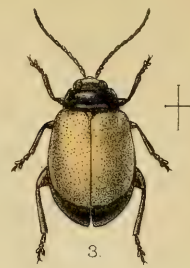
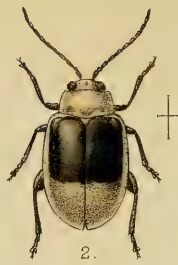
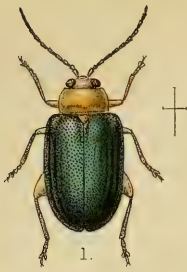
95. *PLATYCERCUS MASTERSIANUS*. (Plate XIX.)

*Platycercus mastersianus*, Ramsay, Pr. Linn. Soc. N.S.W. ii. p. 27 (1877); Salvad. Cat. B. xx. p. 543.

We are so fortunate as to have a single example of this rare bird in the Collection, deposited by Mr. Rothschild on the 29th Oct., 1897, and I have great pleasure in exhibiting a coloured drawing of it prepared by Mr. Smit (Plate XIX.). It is clearly a member of the group of *P. elegans*, but differs from all others in having the central parts of the tail-feathers whitish. Count Salvadori was unacquainted with it, and merely copied the original description in a footnote.







W. Purkiss del. et lith.

West, Newman imp.

## 104. PSEPHOTUS CHRYSOPTERYGIUS.

Of this species, perhaps the most beautiful of all Australian Parrakeets, we received a pair in immature plumage in March 1897. They are now in full plumage and in excellent condition.

## EXPLANATION OF THE PLATES.

## PLATE XVIII.

*Eclectus westermanni*, ♂ and ♀ adult, p. 170.

## PLATE XIX.

*Platyercus mastersianus*, p. 170.

(Taken from specimen deposited on Oct. 29, 1897.)

3. Descriptions of New Species of Coleoptera of the Family  
*Halticidæ* from South and Central America. By  
MARTIN JACOBY, F.E.S.

[Received February 15, 1902.]

(Plate XX.<sup>1</sup>)

The constant application for the determination of so many specimens of *Halticidæ* which I have received from different sources has induced me to describe most of those which are contained in my collection, for a long time unnamed, as a further contribution to the extremely numerous described forms from South and Central America. The subject can scarcely be dealt with at present in anything but a very incomplete manner, but every little helps and will one day assist in grouping together the enormous material known, when the time and opportunity has arrived for a proper monograph of this immense family, such as has been attempted with the species known from Central America, in the great work on that country by Godman and Salvin.

The present paper deals with that division of the *Halticidæ* in which a more or less distinct thoracic sulcus is present in connection with simple, not inflated, posterior claws.

## DIPHAULACA COSTATIPENNIS, sp. n.

Dark metallic blue, the basal joints of the antennæ fulvous; thorax obscure cupreous, impunctate; elytra closely and nearly irregularly punctured, the sides with two or three longitudinal costæ.

Length 4 millim.

Head impunctate, the frontal elevations elongate, divided by a deep groove, the carina acute; antennæ long and slender, black, the lower three joints fulvous below, stained with metallic blue above; thorax subquadrate, the sides straight at the base, rounded

<sup>1</sup> For explanation of the Plate, see p. 204.

before the middle, the angles acute, the basal sulcus very deep, straight, bounded at the sides by a perpendicular groove, the surface entirely impunctate; elytra much wider at the base than the thorax, the basal portion slightly raised, the disc very closely and distinctly punctured, the punctures arranged in indistinct rows, much finer towards the apex, a well-marked costa extends from the shoulders nearly to the apex and is preceded by a shorter one which does not extend upwards to the base, the interstices between these costæ more irregularly and more strongly punctured than the rest of the surface, elytral epipleuræ broad, with a row of punctures; below and the legs metallic blue, impunctate, the last segment of the abdomen with a longitudinal groove which widens at the apex, the sides of the segment slightly raised.

*Hab.* Venezuela.

The single specimen before me is probably a male, although the anterior tarsi are not particularly dilated. The species differs from its allies in the sculpture and costæ of the elytra, in connection with its coloration.

*DIPHAULACA FLAVIPES*, sp. n.

Below piceous, above greenish-æneous, the basal joints of the antennæ and the legs entirely flavous; thorax impunctate, with deep transverse sulcus; elytra with the basal portion convex, scarcely perceptibly punctured except near the base.

Length 4 millim.

Head impunctate, æneous, the frontal elevations small, ovate; antennæ slender, blackish, the lower four joints flavous, the third and fourth of equal length; thorax one-half broader than long, the sides straight at the base, rounded anteriorly, the angles acute, the disc deeply transversely sulcate, the sulcus sinuate, bounded at the sides by a perpendicular groove, entirely impunctate; elytra widened towards the middle, the apex of each rounded, the base distinctly swollen, the shoulders prominent, the surface extremely finely punctured at the base, the punctures scarcely arranged in rows and very closely placed, nearly obsolete below the middle, the epipleuræ very broad, concave; below obscure piceous, the legs entirely flavous.

*Hab.* Colombia (*Pehlke*). Museum Stettin and my collection.

This small species may be at once known by the entirely æneous upper surface and the flavous legs. The specimen before me seems to be a female.

*DIPHAULACA PALLIPES*, sp. n.

Below black, above greenish-æneous, the basal joints of the antennæ and the legs (the posterior femora excepted) flavous; thorax impunctate, the basal sulcus deep; elytra finely punctate-striate, the punctures indistinct near the apex.

Length 2 millim.

Head impunctate, the frontal tubercles narrowly oblique, the carina acute, the lower portion of the face and the labrum black,

the vertex greenish-æneous; the antennæ rather long and slender, flavous, the terminal joints fuscous, the third and fourth joints equal, scarcely longer but much thinner than the second one; thorax twice as broad as long, the sides straight, the anterior angles oblique, forming a distinct tooth before the middle, posterior margin rather broadly produced at the middle, the basal sulcus deep and sinuate, bounded at the sides by deep perpendicular grooves, the surface rather convex, impunctate, greenish-æneous; elytra with the base slightly raised, distinctly punctured in closely approached rows which become obsolete near the apex; legs flavous, the posterior femora blackish.

*Hab.* St. Catharina, Brazil.

Of only half the size of *D. flavipes*, the basal margin of the thorax not straight as in that species, but slightly produced at the middle, the punctuation of the elytra more distinctly arranged in rows, and the posterior femora black, not flavous.

DIPHAULACA FRUHSTORFERI, sp. n.

Greenish-æneous, basal joints of the antennæ and the base of the femora (more or less) testaceous; head deeply foveolate; thorax obsoletely punctured, metallic green or æneous, the basal sulcation deep; elytra with the base raised, rather strongly and closely punctate-striate, metallic green or brassy.

Length  $3\frac{1}{2}$  millim.

Head impunctate, deeply foveolate between the eyes, the latter large and prominent, frontal elevations obsolete, carina acute; antennæ rather long and slender, piceous, the lower four joints and the apical one testaceous, third and fourth joints equal, terminal joints equally long, not thickened; thorax transversely subquadrate, the sides straight, the anterior angles slightly thickened and oblique, the basal sulcus deep, bounded at the sides by equally deep perpendicular grooves, the surface convex, nearly impunctate, brassy green; elytra with the base distinctly raised, the basal margin preceded by a deep groove which extends in front of the shoulders, the surface strongly and closely punctate-striate anteriorly, the punctures very much finer towards the apex, below dark æneous; legs robust, piceous, the femora more or less testaceous at the base, posterior tibiæ slightly curved and dilated at the apex.

*Hab.* St. Catharina, Brazil (*Fruhstorfer*).

Principally distinguished from other species of the genus by the deep frontal fovea, the strong and close punctuation of the elytra, and the colour of the legs.

DIPHAULACA HAROLDI, sp. n.

Below blackish, above greenish-æneous, the basal three joints of the antennæ flavous; thorax transverse, finely punctured; elytra with the basal portion convex, regularly punctate-striate, the striæ remotely placed.

Length  $2\frac{1}{2}$  millim.



Head impunctate, the frontal elevations small, the carina acutely raised; antennæ extending to the middle of the elytra, black, the lower three joints flavous, second and third joints equal, fourth scarcely longer, the terminal joints gradually thickened; thorax quite one-half broader than long, the sides nearly straight, the anterior angles obliquely thickened, the basal sulcus deep, not extending beyond the perpendicular grooves at the sides, the disc convex, remotely and finely punctured, elytra with the base distinctly raised, punctured in regular and not closely placed rows, distinct to the apex, the last row near the lateral margins more strongly punctured, the last interstice slightly convex; below and the legs nearly black; prosternum broadly elongate, distinctly punctured.

*Hab.* Colombia.

One of the smallest species of the genus, and distinguished from its Colombian congeners by the finely but distinctly punctured thorax.

#### Genus LACTICA.

##### a. *Elytra blue or green.*

##### LACTICA BOLIVIANA, sp. n.

Ferruginous, the antennæ (the basal three joints excepted), the apex of the tibiæ, the tarsi, and the abdomen black; elytra violaceous blue, strongly punctured; thorax impunctate, the basal sulcus deep; posterior legs entirely black.

Length 5 millim.

Head impunctate, obliquely grooved above the antennæ, carina short, labrum piceous; eyes very slightly emarginate; antennæ scarcely extending to the middle of the elytra, black, the lower three joints fulvous, third and fourth joints equal, the second one scarcely shorter; thorax twice as broad as long, rather convex, not narrowed anteriorly, the sides straight, the anterior angles oblique, the basal sulcus deep and straight, placed close to the base, the surface impunctate; scutellum fulvous; elytra convex, violaceous blue, distinctly punctured in closely approached irregular rows, distinct to the apex; legs and the breast ferruginous, the apex of the four front tibiæ, the tarsi, the posterior legs entirely, and the abdomen black.

*Hab.* Bolivia.

Closely allied in coloration to *L. elegantula* Har., but much larger, without distinct frontal elevations, the third and fourth joints of the antennæ equal; the head impunctate, and the elytral punctuation distinct to the apex. *L. abdominalis* Jac. is much smaller and has fulvous posterior legs.

##### LACTICA LOBATA, sp. n.

Oblong-ovate, ferruginous, apical joints of the antennæ black; thorax impunctate, the basal sulcus rather deep, basal margin

produced at middle; elytra metallic blue or greenish, finely punctured in rows; abdomen black.

Length  $4\frac{1}{2}$  millim.

Head impunctate, the frontal tubercles entirely obsolete, the carina short, pyriform; eyes large, nearly entire; antennæ extending to about the middle of the elytra, black, the lower four joints ferruginous, the third and fourth joints equal, but little longer than the second joint; thorax twice as broad as long, the sides very feebly rounded, narrowly marginate, the anterior angles oblique, not produced, the basal margin rounded and produced at the middle, the basal sulcus straight and moderately deep, the perpendicular grooves very deep, the surface impunctate, ferruginous; scutellum fulvous; elytra convex, subcylindrical, finely punctured in closely approached rather regular rows, distinct to the apex; breast and legs ferruginous; abdomen black.

*Hab.* Bolivia.

In this species the basal margin of the thorax has a distinct round lobe at the middle, differing in this respect from most of the other species of the genus: this character alone would scarcely justify the creation of another genus, but it will assist in the recognition of the species, in connection with the system of coloration and the black abdomen.

*LACTICA FUNEREA*, sp. n.

Entirely dark violaceous, the last five joints of the antennæ fulvous; thorax transverse, impunctate, the basal sulcus deep; elytra purplish-violaceous, extremely finely punctured.

Length 6 millim.

Elongate, convex, the head impunctate, frontal elevations entirely obsolete; eyes not very large; clypeus thickened, wedge-shaped, carina narrow; antennæ nearly reaching the end of the elytra, black, the last five joints fulvous, the second half the length of the third joint; thorax strongly transverse, more than twice as broad as long, the sides perfectly straight, narrowly margined, the anterior angles oblique, the disc entirely impunctate, blackish-violaceous, the basal sulcus and the perpendicular grooves very deep; elytra metallic purplish-violaceous, very finely punctured when seen under a strong lens; below and the legs nearly black.

*Hab.* Yurimaguas, Peru.

Of this very distinct species, two specimens are in my collection.

*LACTICA COSTATIPENNIS*, sp. n. (Plate XX. fig. 1.)

Flavous, the antennæ (the basal joints excepted) and the tibiæ and tarsi black; thorax impunctate, the basal sulcus deep; elytra bright green, finely rugosely punctate, the sides of each with an acute costa.

Length 6 millim.

Head flat and impunctate, the frontal elevations obsolete

clypeus slightly raised, anterior edge of the labrum black; eyes oblong, slightly sinuate; antennæ extending to the middle of the elytra, black, the lower three joints more or less flavous below, the third joint smaller than the fourth, all the following joints elongate; thorax twice as broad as long, the sides rounded, the anterior angles simple, not oblique, basal sulcus deep, slightly sinuate, the surface flavous, impunctate; scutellum triangular, fuscous; elytra extremely closely and rather finely rugosely punctured, not very shining, with an acute ridge from the shoulders to the apex, accompanied by another shorter ridge below the middle; below flavous, the lower portion of the tibiæ and the tarsi fuscous.

*Hab.* Llano Grande, Guatemala.

I have seen only a single example of this very distinct species, which is in my collection.

*LACTICA BILINEATA*, sp. n.

Flavous, the antennæ black; thorax transverse, impunctate, with deep basal sulcus; elytra metallic blue, microscopically punctured, each with a narrow flavous streak from the base to below the middle.

Length 4 millim.

Head with a few deep punctures near the eyes, flavous, the frontal elevations strongly raised; clypeus flattened, subquadrate, but slightly raised between the eyes; labrum piceous; eyes very large, distinctly emarginate; antennæ piceous, the second joint half the length of the third, the other joints wanting; thorax more than twice as broad as long, very short, the sides straight, the anterior angles oblique, the basal sulcus very deep, placed close to the base and nearly straight, the disc impunctate; scutellum broad, black; elytra elongate and parallel, metallic dark blue, with a few very fine punctures at the base, from the middle of the latter proceeds a narrow flavous stripe which extends to below the middle and is much constricted medially, its direction is towards the suture; below stained with piceous, the legs pale flavous.

*Hab.* Peru.

Easily recognizable on account of its coloration, which is probably variable in regard to the elytral flavous stripes. I possess only a single specimen of this very distinct species.

b. *Elytra with spots or striped.*

*LACTICA SEMINIGRA*, sp. n. (Plate XX, fig. 2.)

Head and thorax flavous, the antennæ, the breast, and legs black; head and thorax, impunctate; elytra flavous, with a subquadrate large black patch from the base to below the middle.

Length 6 millim.

Head impunctate, shining, flavous, with a small fovea between the eyes, clypeus strongly raised in shape of a triangular ridge,

antennæ extending beyond the middle of the elytra, black, the basal joint flavous below, the lower three joints shining, the rest pubescent, third joint much shorter than the fourth; thorax twice as broad as long, the sides straight, the anterior angles oblique, the basal margin rounded and rather prominent at the middle, the basal sulcus shallow, bounded laterally by deep perpendicular grooves, the surface impunctate; scutellum testaceous; elytra not perceptibly punctured, the anterior portion occupied by a large black subquadrate patch which does not extend to the lateral margins, the rest of the surface pale flavous, very shining; the breast and legs black, the abdomen flavous.

*Hab.* Cachabé, Ecuador (*Rosenberg*).

I know only a single specimen of this very distinct species, which is in my collection.

*LACTICA BICOLORATA*, sp. n. (Plate XX. fig. 3.)

Broadly ovate and convex, testaceous, the antennæ, thorax, legs, and the sides of the breast black; elytra minutely punctured, testaceous, the apical portion in shape of a transverse oblique band, black.

Length 6 millim.

Head impunctate, the frontal tubercles flattened, testaceous; antennæ extending to the middle of the elytra, black, the first joint testaceous below, third and following joints elongate, rather robust; thorax nearly three times broader than long, the sides straight, the anterior angles oblique, the basal sulcus shallow, the perpendicular grooves at the sides deep, the surface impunctate, black; scutellum black; elytra widened posteriorly, minutely punctured, testaceous, a transverse band, its inner margin concave and widened at the suture, occupies about the apical fourth portion of the elytra; below testaceous, the sides of the breast and the legs black.

*Hab.* Peru.

Allied to *L. batesi* Baly, but with differently coloured antennæ and legs, and the black elytral portion narrower, the thoracic sulcus also more shallow.

*LACTICA LIMBATIPENNIS*, sp. n.

Ovate, pale testaceous; antennæ very long; thorax impunctate, the basal sulcus very shallow; elytra extremely finely and closely punctured, black, the lateral and apical margins narrowly pale flavous.

*Var.* Elytra testaceous, the basal portion more or less black only.

Length 2 millim.

Head impunctate, flavous; the eyes entire, frontal elevations distinctly raised, clypeus flat; antennæ quite extending to the apex of the elytra, very slender, entirely flavous, the second and following two joints gradually elongated; thorax scarcely twice as broad as long, the sides feebly rounded, the anterior angles not



oblique, the basal sulcus very obsolete as well as the perpendicular grooves, the disc impunctate, flavous; scutellum flavous; elytra extremely closely and minutely punctured, convex, black, surrounded by a pale flavous margin which widens rather at the apex; below and the legs pale testaceous, the middle of the breast sometimes stained with black.

*Hab.* Peru.

There are five specimens of this small species in my collection. Of these two represent the variety which has the base of the elytra black only and the rest of the disc faintly stained with fuscous, so that the pale lateral margins are still plainly distinct.

*c. Elytra entirely pale-coloured.*

*LACTICA PARAGUAYENSIS*, sp. n.

Flavous; antennæ robust, black, the basal three joints flavous; thorax strongly transverse, the basal sulcus rather shallow; elytra parallel, flavous, impunctate, the apex of the femora piceous, the tibiæ and tarsi black.

Length 5 millim.

Of elongate, not very convex shape; the head impunctate with the exception of a single deep puncture near the eyes, the latter not large, frontal elevations only indicated, the carina very broad and convex, clypeus likewise strongly raised; labrum flavous, apex of the mandibles and the palpi piceous; antennæ comparatively robust, black, the lower three joints flavous, stained with piceous above, the second and third joints small, of equal length, the following joints rather dilated; thorax more than twice as broad as long, the sides straight, obliquely narrowed anteriorly, the anterior angles obliquely produced, the basal sulcus shallow, placed close to the base, the lateral perpendicular grooves very deep, the surface entirely impunctate; scutellum rather broad, triangular; elytra impunctate.

*Hab.* Paraguay.

This *Lactica*, of which a single specimen is contained in my collection, may be distinguished by the rather robust antennæ, the rather small-sized and widely separated eyes, and especially by the very transversely shaped thorax and its produced and oblique anterior angles. It differs in this respect from any of the many similarly coloured species of the genus.

*LACTICA APICIPES*, sp. n.

Elongate, moderately convex, testaceous, the antennæ (the basal joint excepted), the apex of the tibiæ, and the tarsi black; thorax impunctate, transverse sulcus shallow, perpendicular grooves deep; elytra extremely minutely punctured.

Length 4-5 millim.

Of elongate, parallel, and moderately convex shape, the head impunctate, the frontal elevations obsolete, carina broad; eyes very



large, slightly emarginate within; antennæ extending below the middle of the elytra, black, the basal joint flavous, second joint less than half the length of the third, the latter slightly shorter than the fourth joint, terminal joints shorter than the intermediate ones; thorax about one-half broader than long, rather flattened, the sides very feebly rounded and very slightly narrowed anteriorly, the anterior angles obsoletely oblique and slightly thickened, the basal sulcus moderately deep in the male, more shallow in the female; elytra microscopically punctured; below and the legs testaceous, the apex of the tibiæ and the tarsi black.

*Hab.* Balthazar (windward side), Grenada, W. Indies (*H. H. Smith*).

I identified this species formerly with *L. tibialis* Oliv., but the three specimens before me, after a closer examination, must represent another species: they are of a very pale testaceous colour, without punctuation of the head and thorax, and all have only the apex of the tibiæ and the tarsi black, differing in that respect from any of its allies. The specimen that I look upon as the male is much smaller, the thoracic sulcus is deeper, and the anterior tarsi have their first joint dilated.

*LACTICA WEISEI*, sp. n.

Ovate, pale fulvous, the antennæ (the basal joint excepted) black, long and slender; thorax transverse, with deep basal sulcus, impunctate; elytra not perceptibly punctured; below and the legs fulvous.

Length 4 millim.

Head with a transverse groove at the vertex and some deep punctures near the eyes, the latter large, deeply emarginate, the intermediate space with a very deep fovea, frontal elevations absent; clypeus broad, ill-defined, and scarcely raised; antennæ nearly extending to the apex of the elytra, black, the lower three joints fulvous, the third joint slightly longer than the second, the following joints very elongate; thorax twice as broad as long, the sides feebly rounded, with a distinct narrow margin, anterior angles obliquely thickened, the basal sulcus very deep and straight, the surface entirely impunctate; elytra ovate, impunctate; underside and legs fulvous; the last abdominal segment triangularly emarginate. (♀?)

*Hab.* Pernambuco.

The structure of the head and the unicolorous legs well distinguish this species.

*LACTICA STRIGATIPES*, sp. n.

Flavous, the antennæ (the basal joint excepted), the apex of the femora above, and the tibiæ and tarsi black; thoracic sulcus deep; thorax and elytra impunctate.

Length  $3\frac{1}{2}$  millim.

Of very convex shape, subcylindrical; the head impunctate, with a rather deep impression above the eyes, the latter elongate,

slightly emarginate, frontal tubercles small and obsolete, labrum piceous; antennæ extending to the apex of the elytra, black, the basal two joints flavous, stained with piceous above, third and fourth joints equal; thorax transverse, slightly narrowed anteriorly, the sides nearly straight, the anterior angles strongly oblique, the surface impunctate, the basal sulcus deep and sinuate; elytra slightly widened towards the middle, impunctate; below and the femora flavous, the latter with a short black streak above near the apex, the tibiæ and tarsi entirely black.

*Hab.* Pichindé, Colombia.

I cannot identify this species, of which three specimens are before me, with any other described *Lactica* on account of the long antennæ, the entirely impunctate upper surface, and the markings of the femora, which are the same in all the specimens. There have been a great many species described of almost similar coloration, of which *L. citrina* Harold is perhaps the most closely allied, but this species has a fine but distinct punctuation and is without the femoral stripe.

*LACTICA SEMIFULVA*, sp. n.

Rufous or flavous, the head and thorax black, shining and impunctate; elytra not perceptibly punctured; antennæ and legs flavous.

Length 4 millim.

Head impunctate, black, shining, the frontal tubercles obsolete, the carina comparatively very broad and convex, clypeus deflexed, labrum pale piceous; antennæ long and slender, entirely fulvous, the third joint slightly shorter than the fourth, this and the following joints nearly equal; thorax transverse, about one-half broader than long, the sides with a narrow margin, straight, the anterior angles oblique, posterior acute; the disc impunctate, black, shining, the basal sulcus deep, bounded at the sides by another deep longitudinal groove; scutellum fulvous; elytra with a shallow depression below the base, of a bright rufous or pale fulvous colour, entirely impunctate, shining; the underside and the legs flavous.

*Hab.* Espirito Santo, Brazil.

Of this very distinct species I possess three specimens, two of which have the elytra of much paler colour than the other. *L. dichroa* Har. seems to be a nearly allied species, but has the antennæ, the underside, and the legs black; this and v. Harold's species are the only members of the genus with which I am acquainted having a black head and thorax and fulvous elytra.

*LACTICA FLAVILABRIS*, sp. n.

Flavous, the head black; thorax short, strongly transverse, impunctate; elytra elongate, parallel and strongly convex, rufous, impunctate.

Length 6 millim.

Head black and shining, the eyes extremely large, the inter-

mediate space very narrow, the frontal tubercles small, the carina acute, the clypeus triangularly raised; labrum flavous, as well as the palpi; antennæ extending to the middle of the elytra, flavous, the last two joints wanting, the second joint half the length of the third; thorax twice as broad as long, narrowed to a slight degree anteriorly, the sides straight, the anterior angles oblique, the disc impunctate, flavous; the basal sulcus very deep, sinuate, and placed rather closely near the basal margin; scutellum rather broad; elytra convex, elongate and widened towards the middle, not perceptibly punctured; below and the legs flavous.

*Hab.* Espirito Santo, Brazil.

Evidently allied to *L. capitata* Illig., but rather smaller, more convex, the antennæ and the labrum entirely flavous, the first-named shorter, the eyes still larger, and the elytra reddish-fulvous, not testaceous.

*LACTICA RUFO-BASALIS*, sp. n.

Elongate, parallel, flavous; the antennæ (the basal joint excepted) black; head and thorax reddish, impunctate, the basal sulcus very deep; elytra impunctate, flavous, the base reddish fulvous; below and the legs flavous.

Length 7 millim.

Head impunctate, reddish fulvous, very shining, the frontal tubercles rather obsolete, carina acute and narrow; eyes large, coarsely granulate, the intermediate space not broader than their diameter; antennæ extending beyond the middle of the elytra, black, the basal joint flavous, the third joint twice as long as the second, but shorter than the fourth joint; thorax about one-half broader than long, slightly narrowed anteriorly, the sides straight, with a rather broad, reflexed margin, the anterior angles oblique, the disc extremely shining, impunctate, the basal sulcus very deep, placed at some distance from the base, the lateral perpendicular grooves still deeper; elytra subcylindrical, scarcely widened at the middle, not distinctly punctured but crowded with numerous piceous specks, the basal margin reddish, the rest of the surface flavous, the metatarsus of the posterior legs as long as the following joints together.

*Hab.* Tejuca, Brazil.

This is a large-sized species, of which a single example is in my collection. It is distinguished by the coloration of the head, thorax, and elytra, the flavous legs, and very deep thoracic sulcus.

*LACTICA FEMORATA*, sp. n.

Flavous, elytra rufous, the posterior femora piceous; head and thorax impunctate, the basal sulcus very deep and sinuate, elytra impunctate.

Length  $2\frac{1}{2}$  millim.

Head impunctate, eyes large, entire, frontal elevations obsolete, carina short, acute; antennæ entirely fulvous, extending beyond

the middle of the elytra, the second and third joints short, nearly equal; thorax twice as broad as long, slightly narrowed anteriorly, the sides nearly straight, the anterior angles oblique, the posterior margin sinuate, the basal sulcus very deep and sinuate, the surface impunctate, flavous; scutellum broad; elytra ovate and convex, with a distinct depression within the shoulders, rufous, shining and impunctate; underside and legs paler, the posterior femora black except at the extreme base, metatarsus of the posterior legs elongate.

*Hab.* Espirito Santo, Brazil.

A small species, distinguished by the colour of the antennæ, of the elytra, and that of the posterior femora.

*LACTICA CLARKI*, sp. n.

Elongate, subdepressed, flavous; labrum and the antennæ (the basal two joints excepted), the knees, tibiæ, and tarsi black; thorax not narrowed in front, impunctate, with deep basal sulcus; elytra narrow and parallel, nearly impunctate.

Length 3 millim.

Head impunctate, the frontal tubercles broad, feebly raised, carina likewise flattened and broad; labrum and palpi black; eyes large, entire; antennæ comparatively short and robust, black, the basal two joints flavous, third joint scarcely shorter than the fourth; thorax transverse, scarcely twice as broad as long, the sides perfectly straight, not narrowed in front, the anterior angles strongly oblique, the lower point of the angles in shape of a small tooth, posterior angles likewise dentiform, the basal sulcus deep and straight as well as the lateral perpendicular grooves, the surface impunctate; scutellum broad, triangular; elytra with some extremely minute punctures, only visible under a strong lens; the knees, tibiæ, and tarsi black, the rest of the underside and the legs flavous.

*Hab.* Paraguay.

A distinct little species on account of the shape of the thorax, which is not narrowed in front as in the majority of the species, and the comparatively robust antennæ; the general shape is also less ovate and convex.

*LACTICA BREVICOLLIS*, sp. n.

Elongate, moderately convex, testaceous; the antennæ (the basal joint excepted), the knees, tibiæ, and tarsi black; thorax one-half broader than long, impunctate, the basal sulcus deep and straight; elytra impunctate.

Length  $4\frac{1}{2}$ –5 millim.

Head impunctate, the frontal elevations distinct and rather broad, the carina narrow and acute; eyes large, entire; antennæ extending beyond the middle of the elytra, black, the basal joint flavous, third joint distinctly shorter than the fourth; thorax only one-half broader than long, distinctly narrowed anteriorly, the sides straight, with a very narrow margin, the anterior angles



but very slightly oblique, the basal sulcus very deep and straight and placed at a proportionately long distance from the base, the disc entirely impunctate; elytra wider at the base than the thorax, not much convex and of parallel shape; below and the legs flavous, the apex of all the femora and the tibiæ and tarsi black.

*Hab.* Colombia, Peru, Venezuela.

The comparatively narrow thorax, entirely impunctate upper surface, the structure of the head (acute carina), and the black apex of all the femora seem to distinguish this from any similarly coloured species of *Lactica* with which I am acquainted; neither can I identify the insect with *L. bogotana* Harold, of which but a superficial description is given and which is described as 7 millim. long, with closely approached eyes and a microscopic but distinct punctuation.

*LACTICA NIGRICORNIS*, sp. n.

Broadly ovate, fulvous; the antennæ, the knees above, the tibiæ, and the tarsi black; thorax transverse, impunctate, the basal sulcus deep and straight; elytra minutely punctured in semi-regular rows.

Length 5 millim.

Of more broadly ovate and less convex shape than the majority of species, of a reddish-fulvous colour; the head impunctate, eyes not very large, entire, frontal elevations entirely obsolete, clypeus convex between the antennæ; labrum piceous, palpi black; the antennæ with rather short and robust joints, extending to about the middle of the elytra, black, the basal joint more or less fulvous below, second and third joints nearly equal; thorax twice as broad as long, slightly narrowed anteriorly, the lateral margins perfectly straight, the anterior angles oblique, not produced, surface impunctate, with a deep and straight basal sulcus; elytra gradually widened posteriorly, very finely punctured in irregular and closely approached rows, indistinct at the apex; below and the legs paler, the knees above, the tibiæ, and tarsi black; tibiæ clothed with fine yellow pubescence.

*Hab.* St. Catharina, Brazil.

Much larger than *L. tibialis* Oliv., with entirely black antennæ, the elytra with a fine and distinct punctuation; the general shape resembling that of *Haltica rufa* Oliv. Two exactly similar specimens are before me.

*LACTICA GRACILICORNIS*, sp. n.

Oblong-ovate, fulvous; the antennæ long and slender, black, the lower three joints flavous; thorax transverse, impunctate, the basal sulcus deep and sinuate, the sides anteriorly with a fovea; elytra extremely finely and closely punctured.

Length 2 millim.

Head with a few punctures near the eyes, the latter large, entire, frontal tubercles small and obsolete, carina narrow and feebly raised, palpi flavous; antennæ extending to the apex of



the elytra, black, the lower three joints flavous, basal joint elongate, the second and third nearly equal, the latter, however, much thinner, the following joints very elongate, the last three thinner than the preceding joints; thorax rather more than twice as broad as long, the sides very feebly rounded, the anterior angles not oblique, the disc impunctate with a transverse impression at the sides near the anterior angles, basal sulcus deep and sinuate, closely placed to the basal margin; elytra convex, with a very shallow depression below the base, extremely minutely and irregularly punctured; underside and the legs flavous.

*Hab.* Mexico.

Of this species I received two specimens from M. Deyrolle, which had been found in Mexican tobacco. The small size, very slender antennæ, the anterior thoracic fovea, and the entirely flavous legs will assist in its recognition.

*LACTICA CARINATA*, sp. n.

Entirely testaceous, of elongate shape; head with a transverse ridge; thorax impunctate, not very transverse, basal sulcus deep and straight; elytra not perceptibly punctured.

Length  $4\frac{1}{2}$  millim.

Head impunctate; frontal elevations obsolete, replaced by a transverse ridge between the eyes; the latter very large, occupying the entire sides of the head; clypeus strongly and acutely raised between the antennæ; the latter extending beyond the middle of the elytra, entirely testaceous, the third joint one-half longer than the second, but much shorter than the fourth joint; thorax scarcely twice as broad as long, slightly narrowed anteriorly, the sides nearly straight, with a narrow reflexed margin, the anterior angles oblique, but not produced, the basal sulcus and the perpendicular grooves deep, the disc impunctate; elytra nearly parallel, impunctate; below and the legs coloured like the upper parts, the metatarsus of the posterior legs elongate.

*Hab.* Cayenne.

There will be no difficulty in distinguishing this species from its allies on account of the transverse ridge between the eyes and the unicolorous legs. I know only a single specimen of this species, which is in my collection.

*LACTICA IMPRESSICOLLIS*, sp. n.

Ovate, fulvous, the antennæ (the lower three joints excepted) black; thorax transverse, with an antemedial transverse depression at the sides, the basal sulcus deep and sinuate; elytra with a shallow depression below the base, impunctate; legs fulvous.

Length 4 millim.

Head deeply punctured near the eyes, the latter large, strongly emarginate, the intra-ocular space raised in two elevations; clypeus bluntly elevated; antennæ extending beyond the middle of the elytra, black, the lower three joints flavous, the second one-half shorter than the third joint, the others closely pubescent;

thorax twice as broad as long, the sides feebly rounded near the base, very slightly narrowed anteriorly, the anterior angles oblique, the basal sulcus deep and rather sinuate, the anterior portion of the thorax impressed with a transverse fovea at the sides, the surface impunctate; elytra widened towards the middle, feebly transversely depressed below the base, impunctate, their epipleuræ very broad and concave.

*Hab.* Bahia.

Amongst the unicolorous species, the present *Lactica* is distinguished by the raised intra-ocular space in shape of two blunt elevations, and by the antemedian fovea of the thorax.

*LACTICA BAHIAENSIS*, sp. n.

Narrowly oblong, entirely testaceous; thorax impunctate, the basal sulcus deep and very sinuate; elytra not perceptibly punctured.

Length 4 millim.

Head with a deeply punctured sulcus round the eyes, the latter large, feebly emarginate, frontal elevations only indicated; clypeus strongly convex between the antennæ; the latter extending below the middle of the elytra, entirely testaceous, the second joint one-half shorter than the third, the fourth longer than the preceding joint; thorax about twice broader than long, the sides straight, the anterior angles oblique, the basal sulcus deep and strongly bisinuate, the disc impunctate; elytra not perceptibly punctured.

*Hab.* Bahia.

I must separate this species from its unicolorous allies on account of the more than usually sinuate thoracic sulcus, in connection with the structure of the head.

#### *LACTINA* Harold.

*LACTINA LÆVICOLLIS*, sp. n.

Dark blue, the thorax nearly subquadrate, entirely impunctate; elytra extremely closely and subrugosely punctured, clothed with very short grey pubescence.

Length 6-7 millim.

*Male.* Head impunctate, the frontal elevations strongly raised, elongate and oblique, carina acute, labrum black; antennæ nearly extending to the apex of the elytra, dark blue, the third and fourth joints equal; thorax about one-half broader than long, the sides nearly straight, the anterior angles slightly produced outwards, the base with the usual deep, sinuate transverse sulcus, the surface entirely impunctate; elytra widened near the apex, extremely closely and rather finely punctured, the interstices very finely wrinkled and clothed with very short greyish hairs; epipleuræ broad, concave and glabrous; the male organ curved and like that of *L. glabrata*, but with the anterior cavity shorter and more ovate, the sides raised and with a blunt ridge within.

*Hab.* Peru.

I must separate this species from any other on account of the impunctate thorax, which even under the strongest lens shows no trace of any punctuation. Examples of both sexes are before me, and do not seem to vary except in the slightly broader thorax of the female.

*LACTINA SEMIRUGOSA*, sp. n.

Metallic green, glabrous above, below bluish; thorax subquadrate, finely punctured, the transverse sulcus deep; elytra widened below the middle, very closely and strongly punctured, the interstices more or less rugose.

Length 7 millim.

Head very finely transversely wrinkled, without punctures, the frontal elevations strongly raised, pyriform, carina acute; antennæ long and slender, metallic blue at the four or five basal joints, the rest black, third and fourth joints equal, shorter than the fifth; thorax about one-half broader than long, the sides nearly straight, very slightly narrowed anteriorly, the surface very finely but not very closely punctured, the basal sulcus deep and nearly straight, bounded laterally by a deep perpendicular groove; scutellum blackish; elytra widened below the middle, without basal depression, comparatively strongly and very closely punctured, with finely wrinkled interstices; below very sparingly pubescent.

*Hab.* Colombia.

I know of no other species of *Lactina* with such strongly punctured elytra in connection with the glabrous upper surface. The description is that of the male, in which the anterior tarsi are dilated, and the last abdominal segment has a central narrow groove; the female does not differ except in the more slender tarsi and the generally rather larger size.

*LACTINA GLABRATA*, sp. n.

Metallic dark blue, glabrous above; thorax one-half broader than long (♂), nearly impunctate, with deep sinuate sulcus; elytra very closely and distinctly punctured.

Length 6 millim.

*Male.* Head impunctate, the frontal tubercles strongly raised, oblique, the carina acute; the antennæ nearly extending to the apex of the elytra, metallic blue, the third joint slightly longer than the fourth and as long as the fifth joint; thorax one-half broader than long, the sides straight at the base, slightly rounded anteriorly, the anterior angles thickened, the surface with a deep sinuate sulcus, the anterior portion rather convex, very minutely and somewhat closely punctured as well as the base below the sulcus; scutellum small, impunctate; elytra convex, not widened posteriorly, attaining their greatest convexity at the middle, very closely and rather strongly punctured, the apex of each rounded, their epipleuræ concave, impubescent; below and the legs smooth, shining; the male organ curved, parallel, the apex rather blunt, with an elongate cavity.


*Hab.* Colombia, Venezuela.

I know of only one other described species which has an impubescent upper surface (*L. chalconota* Har.); but in that species the carina of the head is short and blunt, the thorax is impunctate, the elytra have traces of costæ and are cupreous in colour. In the female of the present species the antennæ are much shorter and the elytra show a slight depression below the base; the insect is also much more robust in shape.

*DISONYCHA DECEMMACULATA*, sp. n.

Black; thorax flavous, with four black spots; elytra strongly punctured, black, each with five flavous spots (2, 2, 1), the one near the scutellum curved; the femora and the abdomen flavous.

Length 4 millim.

Head with a deep punctured groove near the eyes, black, with a flavous mark on the vertex, the frontal elevations distinct, the clypeus strongly convex, flavous; labrum black; antennæ robust, black, the lower four joints flavous below, third joint slightly shorter than the fourth; thorax twice as broad as long, flavous, the sides straight, the anterior angles scarcely oblique, rather rounded, posterior angles oblique, the disc impunctate, with four small black spots placed transversely; elytra strongly and closely punctured, black, each with five yellow spots, one at the humeral callus, another in shape of a  near the scutellum, two round spots at the middle and a transverse one near the apex; the breast, the tibiæ and tarsi black; femora and abdomen flavous, the apex of the posterior femora black.

*Hab.* Pernambuco, Pery-Pery.

This species will be easily recognized by the strong elytral punctuation and the outwardly curved spot near the scutellum.

*DISONYCHA ELONGATA*, sp. n.

Elongate and subdepressed, testaceous, the terminal joints of the antennæ fuscous; thorax impunctate; elytra not perceptibly punctured; a very narrow sutural and a sublateral stripe and a broader longitudinal band at the disc, black.

Length 9 millim.

Head impunctate, the clypeus with an acutely raised central ridge; eyes reniform, rather deeply emarginate; antennæ extending to the middle of the elytra, rather robust, fuscous, the lower four joints testaceous, the fourth joint nearly twice as long as the third; thorax about one-half broader than long, the sides nearly straight with a narrow margin, the posterior angles strongly oblique, anterior angles obliquely truncate; scutellum black; elytra rather flattened, not perceptibly punctured, testaceous, very shining, the suture very narrowly and a slightly wider stripe close to the margins black, another much broader band extends from the middle of the base nearly to the apex; below and the legs testaceous, the apex of the posterior tibiæ obscure fuscous.



*Hab. Venezuela.*

This species closely resembles in coloration and pattern many others of the genus, but may be distinguished by the impunctate elytra, the width of their black stripes, the comparatively narrow and unspotted thorax, and the rather large general size of the insect.

*DISONYCHA BREVICOLLIS, sp. n.*

Oblong, pale testaceous, the antennæ (the basal joints excepted) and the tarsi black; thorax short and transverse, scarcely punctured; elytra closely and distinctly punctured, the sutural and lateral margins and a narrow obsolete discoidal stripe obscure pale fulvous.

Length 6 millim.

Head with a few punctures placed transversely between the eyes, the frontal elevations feebly raised; clypeus broad, testaceous, like the labrum and the rest of the head; eyes rather elongate; antennæ robust, black, the basal three joints flavous; thorax more than twice as broad as long, the sides nearly straight, the anterior angles produced obliquely outwards, the posterior angles oblique but not produced, the basal margin rounded, the disc with a few fine punctures; elytra closely and comparatively strongly punctured, the sutural and discoidal stripes very narrow and obsolete, the lateral margins more broadly marked with pale fulvous; below testaceous, the tarsi black.

*Hab. Ventanas, Mexico.*

This species, which was unknown to me during the publication of the Mexican Phytophaga in the 'Biologia Centr.-Amer.,' is readily distinguished by the shortness of the thorax, the more than usual strong elytral punctuation, and the narrowness and faint coloration of their stripes. Two specimens are in my collection.

*DISONYCHA ANGULATO-FASCIATA, sp. n. (Plate XX. fig. 4.)*

Flavous, the head with two, the thorax with five black spots; elytra impunctate, black, a transverse medially constricted band at the base, another at the middle, and a spot near the apex flavous; the apex of the femora and the tibiæ and tarsi black.

Length 4 millim.

Head with some deep punctures near the eyes, flavous, a spot on the vertex and another small spot between the eyes black, the latter rather large; carina strongly raised; antennæ robust, black, the lower four joints flavous, the basal two stained with black above, third and fourth joints equal; thorax twice as broad as long, the sides straight, very narrowly margined, the anterior angles oblique, the disc impunctate, flavous, with five small black spots (2, 3) placed transversely, the outer ones of the second row the largest, the base with an obsolete transverse sulcus; scutellum black; elytra not perceptibly punctured, with alternate transverse flavous and black bands of angulate shape, the sutural and lateral



margins likewise black; below flavous, the anterior legs entirely, the apex of the femora and the tibiæ and tarsi black.

*Hab.* Pernambuco, Serra de Communitat.

This little species resembles somewhat the well-known *D. austriaca* Schauf., but the design of the elytra is different and consists of two flavous and two black transverse angulate bands and a flavous spot at the apex: the first of these light bands is placed somewhat obliquely at the base, leaving the humeral callus black, the second is situated at the middle and is strongly constricted medially.

*CACOSCELIS GUIANAENSIS*, sp. n.

Flavous, the vertex of the head, the antennæ, the femora above, and the tibiæ and tarsi black; thorax finely punctured, with two black spots; elytra metallic green, strongly and closely punctured, the lateral margins narrowly flavous; tibiæ not emarginate.

Length 10-12 millim.

*Hab.* British Guiana.

I am obliged to separate this species from the well-known *C. marginata* Fab., which it completely resembles in coloration, on account of the entire tibiæ, the same parts in *C. marginata* having a very distinct emargination. Other less striking differences are to be found in the rather stouter antennæ of the present species, in the more transversely shaped thorax, which is closely and finely punctured at the sides and has two large well-separated blackish spots, with sometimes a smaller intermediate one. Fabricius's species is generally found in Brazil. In the present insect the vertex of the head is likewise black, which I have not found to be the case in any specimen of the allied species. *C. compta* Erichs. has the sutural margins flavous as well as the lateral ones. There are four specimens before me.

*CACOSCELIS TIBIALIS*, sp. n.

Below flavous, above fulvous, the antennæ, tibiæ, and tarsi black or piceous; thorax transversely subquadrate, impunctate, obsoletely sulcate; elytra finely and closely punctate-striate.

Length 7-8 millim.

Of elongate and nearly parallel shape, the head impunctate, fulvous, the frontal elevations transverse, bounded behind by a deep groove; clypeus rather strongly raised between the antennæ, its anterior margin straight; labrum flavous, with a few punctures; terminal joint of the palpi acutely pointed; antennæ extending slightly beyond the middle of the elytra, black, slender, the third and fourth joints more slender than the following ones but not longer, basal joint more or less fulvous below; thorax about one-half broader than long, of equal width, the sides rounded, the anterior angles somewhat oblique, the lateral margins accompanied by a depression, the base with a shallow transverse groove; the disc impunctate, fulvous, shining; scutellum triangular, impunctate; elytra finely punctured in closely approached, rather

regular rows, their epipleuræ very broad, continued to the apex; below flavous, the tibiæ and tarsi black (sometimes only infuscate), the posterior tibiæ with a small spur, the others unarmed; prosternum narrow, anterior cavities open.

*Hab.* Espirito Santo, Brazil.

What I take to be the female of this species differs in having a rather broad reflexed lateral margin to the elytra, and the upper surface of a more pronounced fulvous; otherwise there is no difference of any importance. The species differs from *C. flava* Clark and *C. testacea* Cl. in the general smaller size, the arrangement of the elytral punctuation, and in the black tibiæ and tarsi. In the female the elytral interstices are more or less costiform. The species, like several others placed in this genus, has entire, not emarginate tibiæ.

*CACOSCELIS VARIPES*, sp. n.

Below black; head and thorax fulvous, impunctate; elytra dark greenish, opaque, minutely punctured; the anterior and intermediate femora fulvous, the tibiæ and tarsi and the posterior femora black.

Length 10 millim.

Head extremely minutely punctured when seen under a strong lens, fulvous, the frontal elevations subquadrate, rather strongly raised; clypeus with a highly raised blunt ridge between the antennæ, the last-named organs black, the basal joint fulvous, the terminal two joints very elongate, much longer than the preceding ones; thorax nearly twice as broad as long, slightly narrowed anteriorly, the sides feebly rounded, with a rather broad flattened margin, the base with a shallow sulcus, not extending to the sides, the anterior angles slightly thickened, the surface impunctate, fulvous; scutellum broad, black; elytra slightly wider at the base than the thorax, rather convex, of opaque greenish colour, very finely punctured, with a narrow reflexed lateral margin, their epipleuræ very broad and concave; below clothed with grey pubescence, black, the anterior and intermediate femora fulvous; tibiæ not emarginate at the apex, the first joint of the posterior tarsi as long as the following joints together.

*Hab.* Brazil.

Of this species, which differs in coloration from any of its allies, a single specimen is in my collection, without any exact locality. It is somewhat allied in colour to *C. opacipennis* Jac., from Colombia, but differs entirely in the shape of the thorax and the colour of the underside and legs.

*CACOSCELIS CÆRULEIPENNIS*, sp. n.

Pale fulvous, the antennæ (the first joint excepted) black; head and thorax impunctate; elytra dark violaceous blue, finely and closely punctured, with traces of longitudinal sulci.

Length 7 millim.

Head fulvous, entirely impunctate, the frontal elevations

distinct, eyes oblong; antennæ extending beyond the middle of the elytra, black, the basal joint fulvous, the third and following two joints elongate, equal; thorax strongly transverse, slightly narrowed anteriorly and at the base, the sides rounded anteriorly, with a very narrow margin, the surface impunctate, light fulvous; scutellum of similar colour; elytra very distinctly, closely, and somewhat rugosely punctured, with some very obsolete longitudinal sulci, dark violaceous blue; below and the legs pale fulvous, the tarsi infusate.

*Hab.* Brazil.

Of this species I know only a single specimen, which is in my collection. It is allied to *C. violaceipennis* Clark, but the elytra are without the flavous lateral margins, the tibiæ are fulvous, not black, and the antennæ have the basal joint fulvous only.

*OCNOSCELIS BOLIVIANA*, sp. n.

Testaceous; antennæ greenish black; head and thorax greenish or fulvous, nearly impunctate; elytra closely and distinctly punctured, testaceous or obscure fulvous, the base broadly and the sides narrowly metallic green.

Length 5 millim.

*Male.* Of ovate and depressed shape, the head strongly punctured at the vertex, more or less metallic greenish, the frontal tubercles very strongly developed, pyriform; antennæ as long as the body, blackish, the basal joint strongly thickened, the third and fourth equal, terminal joints very elongate and slender; thorax comparatively long, scarcely one-half broader than long, the sides but feebly rounded, with a narrow flattened margin, the posterior angles acute, the anterior angles obsoletely thickened, the disc nearly impunctate and smooth, more or less metallic green, with the sides narrowly fulvous or entirely of the latter colour; scutellum blackish; elytra closely and rather strongly punctured, obscure fulvous, the base more or less metallic green, this colour also extending down at the sides to about the middle of the elytra; below and the legs testaceous, the tibiæ and tarsi generally darker, the intermediate tibiæ of the male strongly curved.

*Hab.* Bolivia.

Like the other three species of this genus, the present one seems rather variable in regard to coloration, but in seven specimens before me the colour of the elytra is constant. The shape of the thorax and the impunctate disc of the latter distinguish the species from its allies. In the female the antennæ are shorter, the thorax is more transverse and is finely punctured.

#### NEPHRICA Harold.

This genus has been established by von Harold on a species having the general appearance of a *Disonycha* or *Asphaera*, but in which the eyes are reniform and emarginate, the sides of the thorax with a narrow margin, and the tibiæ without any emargi-

nation near the apex. All these characters are, however, not wanting in many species of *Disonycha*, and intermediate stages frequently occur in which it is impossible to say to which genus to refer the species. *Nephrica* is therefore not a well-founded genus, and it is impossible to fix the limit between this and *Disonycha*. Nevertheless I have left the question in its present state, and described all those species contained in my collection in which the kidney-shaped eyes and other details peculiar to von Harold's genus are well marked, so that there will be little difficulty in recognizing these forms.

*NEPHRICA BOLIVIANA*, sp. n.

Pale flavous, the base of the head, the antennæ, underside, and legs black; thorax impunctate; elytra extremely minutely punctured, yellowish white, a broad transverse band at the base and another below the middle, not extending to the lateral nor apical margins, metallic green.

Length 6 millim.

Head piceous at the base, impunctate, the lower portion nearly white, the carina distinct and broad; antennæ not extending to the middle of the elytra, piceous, the basal joint flavous below; thorax twice as broad as long, the sides very feebly rounded, with a narrow margin, the anterior angles truncate, the posterior slightly truncate, the surface impunctate, yellowish white; scutellum black; elytra nearly impunctate or with some extremely minute punctures at the sides, metallic green, this colour not quite extending to the lateral nor apical margins, and divided at the middle by a narrow transverse flavous band; below and the legs black (in immature specimens stained with flavous).

*Hab.* Bolivia.

Allied to *N. didyma* Illig. and *N. kirschi* Har., but differing in the design and colour of the elytra. In the above given description I have taken the green colour for that of the ground, but in the diagnosis the pale colour.

*NEPHRICA MACULIPENNIS*, sp. n. (Plate XX. fig. 8.)

Below black, as well as the antennæ and legs; head and thorax flavous, the latter with five small black spots (4, 1); elytra closely punctured, testaceous, the basal margin, the shoulders, a narrow lateral stripe, connected with a broad transverse band below the middle, and a round spot near the latter part, metallic green.

Length 7 millim.

Head sparingly punctured near the eyes, flavous, the extreme vertex black; carina acute, labrum and palpi black; antennæ short, not extending to the middle of the elytra, black, the lower three joints testaceous below, third joint shorter than the fourth, terminal joints slightly thickened; thorax twice as broad as long, the sides feebly rounded, the anterior angles oblique, the surface impunctate, flavous, with four small piceous spots placed transversely anteriorly, and another spot at the middle near the base;



scutellum black; elytra very closely and strongly punctured, testaceous, with the basal and sutural margins, a humeral spot, and a narrow submarginal stripe metallic green; this latter stripe joins a transverse broad band before the apex, while a similarly coloured spot is placed at the middle of the disc on each elytron; below and the legs black, finely pubescent.

*Hab.* Rio Grande do Sul, Brazil.

*NEPHRICA SANGUINOLENTA*, sp. n. (Plate XX. fig. 10.)

Below fuscous, above dark red; thorax obsoletely sulcate, impunctate; elytra very minutely punctured, bright red, the disc with a large subquadrate yellowish patch.

Length 8 millim.

Head impunctate, with the exception of a single puncture near the eyes, the latter kidney-shaped, large; clypeus thickened, but rather broad between the antennæ; the latter extending to the middle of the elytra, dark fulvous, the third joint twice as long as the second and as long as the fourth; thorax rather more than twice as broad as long, the sides nearly straight, slightly obliquely narrowed towards the apex, with a distinct reflexed margin, anterior angles thickened, slightly produced outwards, the disc impunctate, very obsoletely sulcate near the base, dark reddish; elytra closely and extremely minutely punctured, of nearly blood-red colour, the latter interrupted at the middle by a large subquadrate yellowish patch, the anterior edge of which extends rather nearer towards the base than the posterior one towards the apex; below and the legs dark fulvous.

*Hab.* Espirito Santo, Brazil.

A single specimen of this well-marked species is contained in my collection.

*NEPHRICA FULVICORNIS*, sp. n.

Flavous, the antennæ and the legs fulvous, the breast and the posterior femora black; head and thorax impunctate; elytra bluish black, a transverse band at the middle, the apex and the lateral margins flavous.

Length 5 millim.

Head impunctate, pale flavous; eyes large, sinuate, frontal tubercles distinct; clypeus slightly raised, triangular; antennæ robust, fulvous, the third joint distinctly shorter than the fourth; thorax more than twice as broad as long, the sides with a rather broad flattened margin, anterior angles obtusely thickened, the disc impunctate, yellowish white; scutellum black; elytra perceptibly punctured on the pale portion only, bluish black, this colour interrupted by a transverse flavous band at the middle which does not quite extend to the suture, but is connected with the similarly coloured lateral margin, the apex likewise pale flavous; below flavous, the sides of the breast and the posterior femora black.

*Hab.* Amazonia.



This species differs from *N. brasiliensis* and *N. boliviana* in the flavous apex of the elytra and in its general smaller size, also in the colour of the underside and legs.

*NEPHRICA PARAGUAYENSIS*, sp. n.

Dark fulvous; thorax with rounded sides, impunctate; elytra very closely and finely punctured, flavous, the basal and sutural margin, a narrow transverse band before and another below the middle, dark fulvous.

Length 6 millim.

Head finely punctured between the eyes, the frontal elevations obsolete, the carina broad; antennæ fulvous, the third and fourth joints equal; thorax twice as broad as long, the sides strongly rounded and broadly margined, the anterior angles obtusely rounded, the surface impunctate, fulvous; elytra closely and finely punctured, flavous, the base with a narrow fulvous band extending to the shoulders, two other medially constricted bands, one before, the other below the middle, extend across the elytra but do not reach the lateral margins; below and the legs dark fulvous.

*Hab.* Paraguay.

Two exactly similar specimens are before me, which resemble greatly in their markings certain species of the genus *Homophœta*.

*NEPHRICA INCLUSA*, sp. n. (Plate XX. fig. 5.)

Yellowish white, the antennæ, tibiæ, and tarsi black; thorax impunctate, the sides straight; elytra extremely finely punctured, the basal and sutural margins, a transverse band before the middle enclosing a basal spot of the ground-colour, and another transverse band before the apex, reddish fulvous.

Length 7 millim.

Head yellowish white, impunctate, the vertex with a black band; the frontal tubercles, the labrum, and palpi black; clypeus very broad; antennæ black, the third and fourth joints equal; thorax with the sides nearly straight, the anterior angles broadly truncate, the surface impunctate, yellowish white; scutellum black; elytra extremely finely and rather closely punctured, pale flavous, the base and a transverse band before the middle, connected at the shoulders by a narrow longitudinal stripe, fulvous, another narrow band below the middle and the suture narrowly of the latter colour; below and the legs flavous, the posterior femora above and the tibiæ and tarsi black.

*Hab.* —?

This species, of which I unfortunately do not know the locality, but which is probably from Brazil, much resembles *N. paraguayensis*, but has nearly white upper and under sides, and the thorax is of totally different shape, having straight instead of rounded sides, the elytral punctuation also is much finer.

*NEPHRICA CLAVERI*, sp. n. (Plate XX. fig. 9.)

Head, the underside, and the posterior femora black; the

antennæ, thorax, and the legs flavous; thorax impunctate; elytra extremely finely punctured, black, a transverse band before and another one below the middle flavous.

Length 6 millim.

Head black, with a few punctures near the eyes, the frontal tubercles and the carina acutely raised; antennæ extending to the middle of the elytra, flavous, the basal three joints stained with black above; thorax of the usual shape, the sides feebly rounded at the middle, the surface impunctate, flavous, the base with a rather well-marked transverse sinuate sulcus; scutellum black; elytra extremely minutely punctured, black, with a slightly curved flavous transverse band at the middle and another near the apex, their epipleuræ, the underside, and the posterior femora black; the anterior legs, the posterior tibiæ, and all the tarsi flavous; tibiæ entire, not emarginate.

*Hab.* Colombia, Ibagué (*Frère Claver*).

Of this very distinct species I received a specimen from Frère Sébastien at St. Génis Laval, which was obtained by Frère Claver, an ardent explorer of parts of Colombia.

*NEPHRICA STAUDINGERI*, sp. n. (Plate XX. fig. 11.)

Flavous, the base of the head, the antennæ and legs fulvous; thorax impunctate, flavous; elytra dark fulvous, impunctate, a round spot at the base, a transverse band at the middle, another near the apex, and the lateral margins narrowly, flavous.

Length 5 millim.

Head with one or two deep punctures near the eyes, the vertex piceous, the lower portion flavous, frontal elevations obsolete, the carina distinct; labrum piceous; the antennæ dark fulvous, the fourth joint slightly longer than the third; thorax with the sides nearly straight, the anterior angles truncate but not produced, the base with an obsolete transverse sulcus, the surface impunctate, flavous; scutellum flavous; elytra entirely impunctate, dark fulvous, each elytron with a round flavous spot at the base, a slightly curved transverse band at the middle, and another one near the apex, the lateral margins likewise very narrowly flavous as well as the outer margin of the elytral epipleuræ; below flavous, the legs dark fulvous.

*Hab.* Amazonia.

This little species very much resembles *Disonycha austriaca* Schauf., but the elytra are fulvous, not black, and have flavous lateral margins.

*NEPHRICA TERMINATA*, sp. n.

Black, the thorax testaceous, impunctate, the disc black; elytra very finely and closely punctured, testaceous, the basal margin and a triangular apical spot black.

Length  $5\frac{1}{2}$  millim.

Head impunctate, with the exception of a deep puncture near the eyes, black, shining; the base of the antennæ and the clypeus

flavous, labrum and palpi black; antennæ rather slender, black, all the joints, with the exception of the second, nearly equal; thorax with the sides straight, the anterior angles broadly truncate and rather produced, the surface with the usual obsolete transverse sulcus near the base, impunctate, testaceous, the disc with a triangular black band or spot at the middle; scutellum black; elytra with the base narrowly black, this colour extending to the shoulders, the apex with another triangular black spot; below and the legs black, the base of all the femora flavous.

*Hab.* Upper Amazons.

*NEPHRICA BRASILIENSIS*, sp. n. (Plate XX. fig. 6.)

Pale fulvous, the head, antennæ, and the legs black; thorax yellowish white, impunctate, scutellum black; elytra scarcely perceptibly punctured, black, shining, the lateral margins and a large transverse patch at the middle yellowish white.

Length 8 millim.

Head black, with a single puncture near the eyes, the latter very large, kidney-shaped; clypeus flavous, triangularly raised, labrum and palpi black; antennæ rather short and robust, black, the third joint twice as long as the second and nearly equal to the fourth joint, intermediate joints slightly widened; thorax nearly three times broader than long, slightly narrowed in front, the sides nearly straight, with rather broad, strongly reflexed lateral margins; anterior angles obtusely thickened, the surface impunctate, very shining, nearly white, with a very obsolete sulcus near the base; elytra convex, widened towards the middle, with narrow lateral margins, nearly impunctate, shining black, this colour interrupted at the middle by a large transverse yellowish patch, which does not quite extend to the suture, but is connected at the sides with the similarly coloured lateral margin; below pale fulvous, the legs black, the extreme base of the posterior femora fulvous.

*Hab.* Rio Janeiro.

A rather large and convex species, well distinguished by its coloration.

*NEPHRICA IMITANS*, sp. n.

Testaceous, the antennæ, tibiæ, and tarsi black; thorax impunctate, obsolete sulcate near the base; elytra impunctate, a broad sutural and discoidal band and a very narrow sublateral stripe black.

Length 7 millim.

Head impunctate, the frontal tubercles obsolete, the carina acutely raised, eyes broadly emarginate; antennæ black, the basal two joints testaceous below, the fourth joint longer than the third; thorax of usual transverse shape, the sides very feebly rounded at the middle, the anterior angles strongly obliquely truncate, the posterior margin emarginate in front of the scu-

tellum; the disc impunctate, testaceous, very obsoletely transversely sulcate near the base; scutellum black, margined with testaceous; elytra rather broadly ovate, impunctate, with a broad sutural and a very narrow sublateral black band, the disc with another broad band not quite extending to the apex, their epipleuræ testaceous, black at their inner portion near the base; below and the legs testaceous, the tibiæ and tarsi blackish.

*Hab.* Peru.

Shorter and broader than *Disonycha elongata*, the sutural band much wider and the antennæ and legs differently coloured; the thorax is also more transverse in shape and the posterior angles less obliquely cut; the elytral pattern resembles entirely that of many species of *Disonycha*, but the eyes are distinctly reniform and the thorax is of different shape.

NEPHRICA NIGROFASCIATA, sp. n.

Black, the apical joints of the antennæ and the legs flavous; thorax impunctate, flavous; elytra very closely and distinctly punctured, black, a subsutural and a sublateral narrow band, connected at the apex, flavous, apex of the posterior femora black.

Length 8 millim.

Head black, shining, impunctate, with the exception of a few punctures near the eyes, the latter very large, reniform; antennæ with the basal and the last four joints flavous, the others black; thorax twice as broad as long, the sides straight, the angles obliquely truncate, the surface flavous, impunctate; elytra closely, strongly, and irregularly punctured, flavous, the sutural and lateral margins narrowly black, the disc occupied by a broad longitudinal band which does not extend to the apex; below black, the femora and tibiæ flavous, the apex of the posterior femora and all the tarsi black.

*Hab.* Espirito Santo, Brazil.

A large species, easy of recognition on account of the colour of the antennæ and strong elytral punctuation, and resembling much a species of *Disonycha*, from which the shape of the eyes will distinguish it; the basal margin of the thorax is scarcely oblique at the posterior angles and altogether different in shape than in *Disonycha*.

NEPHRICA UNIFASCIATA, sp. n. (Plate XX. fig. 7.)

Black, the thorax fulvous, impunctate, obsoletely sulcate; elytra black, shining and impunctate, a round spot at the base of each and a transverse band near the apex white; abdomen fulvous.

Length 6 millim.

Head black, with a single deep puncture near the eyes, the latter large, reniform, frontal tubercles obsolete, carina strongly raised; antennæ black, the second and third joints small, nearly equal, the fourth elongate; thorax scarcely twice as broad



as long, the sides straight, not narrowed anteriorly, with a very narrow margin, anterior angles feebly truncate, the surface impunctate, fulvous, with an obsolete shallow sulcus near the base, posterior angles scarcely oblique; scutellum black; elytra very shining, black, slightly depressed below the base, not perceptibly punctured, a round spot, placed at the middle of the base, and a transverse, very regular band near the apex yellowish white; below and the legs black; abdomen fulvous.

*Hab.* Peru.

A very distinct species on account of its coloration.

*SYSTEMA CLARKI*, sp. n.

Testaceous; thorax transversely subquadrate, impunctate; elytra dark fuscous, the basal margin narrowly testaceous, the surface impunctate.

Length 3 millim.

Head impunctate, testaceous or pale fulvous, the frontal elevations distinct, subquadrate; antennæ entirely flavous, the third joint not longer than the fourth, the terminal joints slightly thickened; thorax about one-half broader than long, the sides rounded at the middle, distinctly constricted at the base, the angles acute, the surface with a shallow but distinct basal sulcus, impunctate, obscure testaceous or fulvous; scutellum flavous; elytra wider at the base than the thorax, entirely impunctate, dark fuscous or nearly black, the base narrowly testaceous; below and the legs testaceous; prosternum extremely narrow, the posterior femora but moderately thickened, with a piceous short streak above near the apex, the metatarsus of the posterior legs elongate.

*Hab.* Colombia.

There are three specimens of this species contained in my collection; the thorax is of rather convex shape, more so than is generally the case in this genus, and the first joint of the posterior tibiae is proportionately long, but there is nothing to separate the species generically.

*SYSTEMA PUNCTATISSIMA*, sp. n.

Below black, above pale testaceous, antennæ fuscous; the head remotely, the thorax and the elytra very closely and finely punctured.

Length 4 millim.

Head distinctly but not closely punctured, the frontal tubercles feeble, the labrum piceous; antennæ rather stout, entirely pale fulvous, the joints slightly stained with fuscous above, terminal joints slightly stouter and shorter than the preceding ones; thorax one-half broader than long, the sides distinctly rounded at the middle, the anterior angles rather obsolete, the surface very closely punctured at the sides, less closely at the middle, the basal sulcus very feeble; elytra with a slight transverse



depression below the base, punctured like the thorax and of the same colour, the suture slightly infusate; below black, legs testaceous, the posterior tibiæ deeply channelled at the apical portion and also emarginate.

*Hab.* La Plata.

Of this very distinct species I possess two specimens; in one of these the basal joint of the antennæ and the apex of the others is more distinctly marked with fuscous.

*SYSTEMA BRASILIENSIS*, sp. n.

Testaceous, the antennæ (the basal joints excepted) black; thorax very minutely punctured, the sides with or without a black stripe; elytra extremely finely and closely punctured, black, the lateral and apical margins narrowly testaceous; abdomen black.

Length 5 millim.

Head impunctate, testaceous or flavous, the frontal elevations feebly raised, clypeus rather depressed anteriorly, scarcely separated from the face; antennæ not extending to the middle of the elytra, black, the lower four joints testaceous below, the terminal five joints distinctly shorter than the preceding ones; thorax of usual shape, the sides straight at the base, slightly rounded anteriorly, the anterior angles obtuse, the basal sulcus shallow but distinct, slightly sinuate, the surface with a few scarcely perceptible punctures, testaceous, the sides with a narrow black band; scutellum black; elytra with an obsolete depression below the base, very closely and finely punctured, black, the lateral margins narrowly and the apical one more broadly pale testaceous; below and the legs testaceous, the abdomen black, the posterior femora black at the apex.

*Hab.* St. Catharina, Espirito Santo, Brazil.

There are six specimens of this distinct species before me, in some of which the lateral thoracic stripe is more or less or entirely obliterated. The species may be distinguished from similarly coloured varieties of *S. variabilis* Jac., from Panama, by the black abdomen, the shorter antennæ, the more distinctly marked thoracic sulcus, and the black apex of the posterior femora.

*SYSTEMA ABBREVIATA*, sp. n.

Below black, basal joints of the antennæ fulvous, lower part of the face flavous; thorax finely punctured, testaceous, with a transverse black band; elytra minutely punctured, testaceous, a subsutural and a sublateral stripe, abbreviated behind, black; legs testaceous.

Length 5 millim.

Head very finely wrinkled at the vertex, the latter piceous or black, the lower portion flavous; antennæ piceous, the lower four joints flavous, fourth joint longer than the third; thorax twice as broad as long, the sides feebly rounded before the middle,

narrowly emarginate, the anterior angles obtuse, posterior angles distinct, the base with a narrow transverse sulcus, the disc scarcely perceptibly punctured and wrinkled, black, all the margins narrowly flavous; scutellum black; elytra sculptured like the thorax, the fine punctures closely placed, the ground-colour flavous or testaceous, a rather broad longitudinal stripe near the suture, and another narrower one near the lateral margins, both abbreviated behind, black.

*Hab.* Puebla, Mexico.

Of this species, which seems to be very rare, as I did not meet with it in the numerous collections I had before me when working out the Central American fauna, I have two exactly similar specimens now: they differ from the other species in the black thoracic band, the two posteriorly abbreviated elytral stripes, and the black underside; of the stripes, the subsutural one is of the same width as that of the following flavous space, but the lateral one is narrower. *D. discicollis* Clark has a black head, differently coloured legs and elytra, the latter are black with a discoidal flavous stripe.

OXYGONA BRASILIENSIS, sp. n.

Testaceous or pale flavous, the antennæ piceous; thorax impunctate, not strongly transverse, the angles acute; elytra finely and closely punctured.

Length 6 millim.

Head broad, impunctate, without any foveæ, the frontal elevations strongly raised; the clypeus triangular; the antennæ piceous or fuscous, nearly extending to the end of the elytra, the third and following joints elongate, equal, terminal joints shorter; thorax not much more than one-half broader than long, the sides rather strongly rounded anteriorly, all the angles acute, the anterior ones slightly oblique but scarcely produced, the surface smooth and shining, with a narrow margin at all the sides; scutellum more or less fuscous; elytra extremely closely and rather finely punctured, the apex nearly impunctate; below and the legs testaceous, the metatarsus of the posterior legs elongate, the prosternum extremely narrow, the last abdominal segment of the male triangularly emarginate at the apex, with a narrow central groove.

*Hab.* Espirito Santo, Brazil.

I must separate this species from *O. acutangula* Chev., on account of the much longer and much less transversely shaped thorax, which is very obvious when the two insects are compared in both sexes. *O. luridulus* Cl. and *O. simplex* Cl. have both flavous antennæ; the former has also a medial fovea on the head, but what Clark meant by a short, deep, and broad medial marking on the head, of which he says nothing in his description, it is difficult to understand. Two specimens of the present species are in my collection.

*OXYGONA NIGRICOLLIS*, sp. n.

Black, head and thorax impunctate; elytra pale flavous, nearly impunctate.

Length 5-6 millim.

Head entirely impunctate, with an oblique depression above the eyes, the frontal tubercles strongly raised, the carina short and broad; antennæ black, extending beyond the middle of the elytra, the third and the following two joints very elongate, the others shorter; thorax more than twice as broad as long, the sides subangulately rounded before the middle, strongly narrowed at the base, with a broad reflexed margin, the anterior margin accompanied by a narrow sulcus, the disc entirely impunctate, shining, black; scutellum black; elytra pale flavous, extremely minutely punctured; below and the legs black.

*Hab.* Espirito Santo, Brazil.

This typical *Oxygona*, of which three specimens are before me, is well distinguished by its system of coloration.

*CREPIDODERA FLAVOMACULATA*, sp. n.

Piceous, above black, the basal joints of the antennæ and the legs (the posterior femora excepted) testaceous; thorax opaque, minutely punctured and granulate, feebly transversely sulcate; elytra very closely punctate-striate, piceous, the humeral callus and the apex flavous.

Length  $2\frac{1}{2}$  millim.

Head entirely impunctate, black, the frontal elevations obsolete, clypeus convex between the antennæ, labrum flavous; antennæ extending beyond the middle of the elytra, testaceous, the terminal joints more or less darkened, second and third joints of equal length, shorter than the fourth, terminal joints thickened; thorax subquadrate, one-half broader than long, the sides nearly straight, the angles distinct, the surface opaque, finely punctured and minutely granulate, the basal sulcus feeble, not extending to the sides, the space below it also distinctly punctured; scutellum black, impunctate; elytra wider at the base than the thorax, extremely closely punctured in irregular rows, the apex much more finely punctate, the disc blackish, the shoulders with a small flavous spot, the apex more or less broadly of the latter colour, the space along the suture somewhat depressed; below piceous, the legs testaceous or flavous, the posterior femora piceous, their metatarsus as long as the two following joints together, all the tibiæ with a small spine, prosternum very narrow; the anterior coxal cavities closed.

*Hab.* Concepcion, Talcahuano, Chili.

The thorax in this species is of an opaque, silky appearance and the sulcus but feebly impressed, although distinct. I cannot refer this insect to any of the species described by Philippi from the same country.

## CREPIDODERA (CHALCOIDES ?) ERICHSONI, sp. n.

Greenish-aneous, above metallic greenish-cupreous, antennæ flavous; thorax convex, finely and closely punctured, the basal sulcus indistinct, the lateral grooves deep; elytra with deep basal depression, distinctly and regularly punctate-striate, tibiæ more or less fulvous.

Length 3 millim.

Of rather broadly ovate and convex shape, the head impunctate, with the exception of a few fine punctures near the eyes, the latter with oblique grooves from the inner margin to the middle of the head, the frontal tubercles obsolete, the carina strongly raised, terminal joint of the palpi acute and slender; the antennæ rather long, flavous, the third joint very slightly shorter than the second, the fourth and following joints more elongate, terminal ones slightly thickened; thorax transversely convex, the sides nearly straight, the anterior angles oblique, slightly thickened, the basal margin sinuate near the scutellum, rather broadly produced at the middle, the basal sulcus feeble at the middle, more deeply impressed at the sides, slightly sinuate, limited laterally by deep, somewhat curved, perpendicular grooves, the disc strongly convex, closely and finely punctured; scutellum small, blackish; elytra scarcely wider at the base than the thorax, the basal portion rather strongly raised, bounded by a transverse depression, the disc convex, subcylindrical, finely and regularly punctate-striate, metallic green with coppery reflections; below greenish-aneous, distinctly punctured, the legs piceous, the tibiæ obscure fulvous at the base, tarsi blackish, the first joint of the posterior tarsi as long as the following two joints together; prosternum rather broad; coxal cavities closed.

*Hab.* Peru.

The single specimen of this species contained in my collection does not quite agree with any of the genera allied to *Crepidodera*, on account of the produced median lobe of the thorax, which gives the latter quite a different appearance from that of the other species; this lobe is not pointed but strongly rounded, and the species ought perhaps to be placed in a special genus, but this may be deferred until more similarly structured species turn up.

## CREPIDODERA MAGISTRALIS, sp. n.

Rufous, the antennæ (the basal joints excepted) and the tibiæ and tarsi black; thorax transverse, impunctate, with deep basal sulcus; elytra metallic greenish, very closely semi-punctate-striate.

Length 7 millim.

Head impunctate, frontal tubercles acute, carina short; antennæ extending to about the middle of the elytra, black, the lower three joints fulvous, the third joint shorter than the fourth; thorax about two-thirds as broad as long, the sides rounded, the anterior angles slightly thickened and produced, the basal sulcus deep and slightly sinuate, bounded at the sides by a perpendicular



groove, the surface, like the head, rufous and impunctate; scutellum of the latter colour; elytra greenish-æneous, with very closely approached and irregular rows of rather fine punctures, which are evenly distributed over the entire surface; below rufous, the abdomen paler, the tibiæ and tarsi more or less black; the prosternum rather broad, elongate.

*Hab.* Peru.

I know only a single specimen of this large species, which seems allied to *C. consularis* Har. from Colombia, but differs in the colour of the underside, the different comparative length of the joints of the antennæ, and the non-continued thoracic sulcus.

NASIGONA, gen. n.

Body elongate; antennæ filiform; lower portion of the face concave, the clypeus not separated; thorax transverse, the anterior angles oblique, the surface obsoletely sulcate near the base; elytra closely punctate-striate, their epipleuræ broad, concave, the anterior and intermediate tibiæ unarmed, posterior tibiæ with a small spine, non-sulcate, the metatarsus of the posterior legs as long as the following joints together, claws appendiculate; prosternum narrowly elongate; the anterior coxal cavities closed.

The genus here proposed is allied to *Oxygona*, *Nasidia* Har., and *Systema*, but differs from all of them in the structure of the head, which at its lower portion resembles that of some genera of *Longicornia* or of *Loxoprotopus* among the *Halticidæ*; the structure of the antennæ and the shape of the thorax differ likewise from *Nasidia*, and the punctate-striate elytra from *Oxygona*. From *Systema* the genus may be separated by the structure of the head and the very elongate joints of the antennæ, as well as by the punctate-striate elytra.

NASIGONA PALLIDA, sp. n. (Plate XX. fig. 12.)

Entirely pale testaceous; antennæ black, the apical three joints testaceous, head and thorax impunctate; elytra strongly punctate-striate, the punctures nearly obsolete at the apex, a spot near the scutellum and another near the apex piceous.

*Var.* Elytra without spots.

Length 5 millim.

Head entirely impunctate, testaceous, the frontal elevations raised anteriorly and divided by an elongate fovea; clypeus forming a single piece, perpendicular, with a feeble central and lateral ridge, the anterior edge likewise narrowly raised; labrum large, apex of the mandibles black; antennæ slender, all the joints, with the exception of the second, very elongate, the basal one and the last three joints testaceous, the others black; thorax twice as broad as long, the sides distinctly constricted at the base, rounded anteriorly, the anterior angles oblique, the surface impunctate; scutellum rather broad, impunctate; elytra wider at the base than the thorax, the base slightly raised, strongly punctured in closely approached rows, the interstices more or less distinctly



longitudinally sulcate and slightly rugose or wrinkled, also more or less distinctly punctured.

*Hab.* Chanchamayo, Peru.

Of the spotted form, a single specimen is before me; these spots are nearly round, one is placed at the base near the scutellum, the other in a line near the apex. I look upon this specimen as the normal form, although four others, contained in my collection, have no elytral spots; there are no other differences between the two forms.

#### EXPLANATION OF PLATE XX.

- Fig. 1. *Lactica costatipennis*, p. 175.  
 2. " *seminigra*, p. 176.  
 3. " *bicolorata*, p. 177.  
 4. *Disonychia angulato-fasciata*, p. 188.  
 5. *Nephrica inclusa*, p. 194.  
 6. " *brasiliensis*, p. 196.  
 7. " *unifasciata*, p. 197.  
 8. " *maculipennis*, p. 192.  
 9. " *claveri*, p. 194.  
 10. " *sanguinolenta*, p. 193.  
 11. " *staudingeri*, p. 195.  
 12. *Nasigona pallida*, p. 203.

March 18, 1902.

W. T. BLANFORD, Esq., LL.D., F.R.S., Vice-President,  
 in the Chair.

A series of mounted specimens of Insects reared in the Insect-house during the past year was laid upon the table, and the following report, drawn up by Mr. Arthur Thomson, the Assistant Superintendent of the Society's Gardens, was read:—

#### *Report on the Insect-house for 1901.*

The following is a list of the Lepidopterous Insects exhibited in 1901:—

#### *Silk-producing Bombyces and their Allies.*

##### Asiatic.

<i>Attacus atlas.</i>	<i>Antheraea mylitta.</i>
— <i>cynthia.</i>	— <i>yama-mai.</i>
— <i>ricini.</i>	<i>Caligula japonica.</i>
<i>Rhodia fugax.</i>	— <i>simla.</i>

##### American.

<i>Samia cecropia.</i>	<i>Telea polyphemus.</i>
— <i>gloveri.</i>	— <i>promethea.</i>
— <i>ceanothi.</i>	<i>Hypochera io.</i>
— <i>euryalus.</i>	<i>Dirphia tarquinia.</i>
<i>Attacus orizaba</i>	<i>Eacles imperialis.</i>
<i>Actias luna.</i>	

## African.

<i>Nudaurelia cytherea.</i>	* <i>Nudaurelia wahlbergi.</i>
* — <i>zambesina.</i>	<i>Gonomita postica.</i>
— <i>tyrrhea.</i>	

*Diurnal Lepidoptera.*

## European.

<i>Papilio machaon.</i>	* <i>Limenitis camilla.</i>
— <i>podalirius.</i>	<i>Charaxes jasius.</i>
<i>Thais polyxena.</i>	<i>Vanessa antiopa.</i>

## American.

<i>Papilio asterias.</i>	<i>Papilio zolaicon.</i>
— <i>ajax.</i>	<i>Limenitis disippus.</i>
— <i>cresphontes.</i>	— <i>ursula.</i>
— <i>troilus.</i>	

*Nocturnal Lepidoptera.*

<i>Acherontia atropos.</i>	<i>Deilephila euphorbiae.</i>
<i>Smerinthus ocellatus.</i>	<i>Chærocampa alecto.</i>
— <i>tilia.</i>	— <i>elpenor.</i>
<i>Sphinx ligustri.</i>	<i>Ceratonia amyntor.</i>
— <i>pinastri.</i>	

\* New to Collection.

Of the Lepidopterous insects which I have the honour to place before the meeting, the specimens of *Nudaurelia zambesina*, *N. wahlbergi*, and of a South African *Cossus*, presented by Mr. W. L. Slater, are exhibited for the first time. The specimens of *Nudaurelia* were received from near Pretoria. For the other specimens of African Bombyces (which have been exhibited before under the generic name of *Antheraea*) the Society are indebted to Messrs. W. L. Slater, F.Z.S., H. W. Bell Marley, and Majors Young & Clarke. For the cocoons of *Dirphia tarquinia* the Society are indebted to Dr. A. E. Goeldi, C.M.Z.S., Pará.

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Mr. R. E. Holding exhibited and made remarks upon the skull of a "Hummel," or Hornless Stag, shot at Glen Tana, and the skull of a Stag in which the left horn had been absent from birth; also the skull of a Welsh Sheep having four horns, a rare occurrence in this breed; besides several specimens of horns of Cattle showing bifurcation of the core-nodules in the horns and other peculiarities.

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Mr. R. Trimen, F.R.S., communicated a paper by Lieut.-Col. J. M. Fawcett, entitled "Notes on the Transformations of some South-African Lepidoptera." This memoir was in continuation of one by the same author, already published in the Society's

'Transactions' (vol. xv. p. 291). It illustrated the earlier stages of 32 species, of which 6 belonged to the Rhopalocera and 26 to the Heterocera. As in the previous memoir, the *Sphingidæ* and the several families of the Bombyces predominated in the series illustrated, and many of these were of special interest in connection with what was known of the earlier stages of the same groups of allied species in the Oriental Region.

This Memoir will be printed entire in the Society's 'Transactions.'

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The following papers were read :—

1. The Evolution of Horns and Antlers.

By HANS GADOW, M.A., Ph.D., F.R.S., F.Z.S.

[Received March 18, 1902.]

(Text-figure 25.)

There are three works to which we naturally turn for information concerning mammalian structures: Flower and Lydekker's 'Study of the Mammalia,' Bronn's 'Thierreich,' Mammalia by Giebel, continued by Leche, and Gegenbaur's 'Vergleichende Anatomie der Wirbelthiere.' But the treatment of the morphology and phylogeny of the Ruminants' horns and antlers in all of them is singularly deficient and inadequate.

The actual development of Horns and Antlers has been studied often enough, but no subsequent writer has taken the trouble of sifting and reconciling the various contradictory statements. Sandifort, in 1829, stated that the bone-core of the Bovine horn is a compound structure, composed of a frontal outgrowth or pedicle, and a superimposed ossification in a cartilaginous matrix—the os cornu, which soon becomes indistinguishably connected with the pedicle by synostosis, so much indeed that the frontal sinuses in time extend not only into the pedicle, but also into this os cornu. Lieberkühn found cartilage in the budding prickets of the Roebuck. Cartilaginous preformation, with subsequent metaplastic ossification, was advocated also by Joh. Müller, Gegenbaur, Kassowitz, and others. Landois declared the development and ossification of the antlers as entirely periosteal. Julius Wolff and Robin et Herrmann deny the existence of cartilage, and call the ground-substance of the budding antler amorphous embryonal tissue, or "substance pré-osseuse."

Rütimeyer, most careful observer and far-seeing thinker, naturally homologized the os cornu of the Bovidæ with the deciduous antler of the Cervidæ; but the os cornu seems to have fallen into oblivion until A. Brandt, as late as 1892, rediscovered, or, rather, reinstated it. Brandt gives the following synoptic table of "Haut- und Knochen Hoerner" (*i. e.* epidermal and bony





loosely in the skin, and even shift their position across the fronto-parietal suture, and fuse very late with the cranial bones. He naturally combats Rüttimeyer's comparison of the antlers with the Giraffe's "horns," which he seems to look upon as *sui generis*.

Not a few writers, amongst them Nitsche and Rørig, are not clear about the meaning of the somewhat unfortunate terms "Hautknochen," dermal or membrane-bones. Rørig, for instance, thinks that thereby are meant epidermal organs. In reality they are contrasted with cartilage-bones as membrane-bones. To call the latter promiscuously dermal bones has caused endless confusion. A necessary condition for ossification is the presence of an amorphous ground-substance or matrix, which is then converted into, or rather supplanted by, bony tissue. Ossification is consequently always a secondary process. Unless the ground-substance is preformed as amorphous embryonic tissue, it has first to be produced out of existing adult cartilage or other connective tissue by the action of the osteoclasts or similar katabolic, histioblastic cells, which by their breaking-down action upon the tissue dissolve the latter into a medium in which osteoblasts can live, multiply, and by excreting or attracting and arranging around themselves certain salts, turn into bone-corpuscles. On the surface of regenerating bone the marrow-cells, giant-cells, myeloplaxes, seem to produce this ground-substance. In the case of cartilage this is first destroyed, one might as well say dissolved, by the cells which immigrate through the perichondrium, a process which happens frequently when membrane-bone comes into contact with cartilage. It was a great step forwards when it became understood that the place of origin of all bone-forming cells was to be referred to the so-called basal membrane of the epidermis, whence osteoblasts infiltrated or invaded the corium or mesodermal portion of the skin. Recent observations warrant us to go a step further, and to assume that the original home of all skleroblasts was in the Malpighian layer of the epiderm itself. The oldest immigration of skleroblasts from the ectoderm into cutis and other mesodermal tissue has formed cartilage; the next immigration of skleroblasts has given rise to bone. The latter being superior, supersedes the cartilaginous skeleton. The ectoderm has by no means lost the capacity of producing either kind of skleroblasts. Extraordinary excitement and requirements, reactions upon external stimulus, produce this rejuvenescence, even in the mammalian skin.

Exquisite examples of true dermal bones are those ossifications "within the skin" which in Amphibia and Reptiles are now generally called osteoderms. They occur also, among Mammalia, in the Armadillos, but in no other group of this class, unless it were in the Cetacea, where Kuekenthal has found traces of a dermal armour. In the Amphibian *Ceratophrys ornata* the "dorsal shield," although very thick itself, has sunk in so deeply that it is now in contact with the vertebral processes and is covered by the ordinary, movable skin. In *Pelobates* the skin of the upper surface of the head is partly co-ossified with the underlying cranial bones, giving them a pitted appearance. Now, frontal and parietal being membrane-bones, or at least membranes which have received their bone from the cutis, this superimposed ossifying mass of *Pelobates* is a second instalment, or second generation of dermal bone. Similar successive repetitions of the same process are demonstrated in those Amphibian and Reptilian vomers which carry teeth, the vomers themselves having resulted from the fusion of the basal portions of teeth which themselves are now lost.—Concerning the cranial membrane-bones, there is no doubt that the original cartilaginous roof has vanished (it is restricted to the dura mater), not because its cartilage has been destroyed, or supplanted, by immigrating bony tissue, but because it has been gradually suppressed by the approaching, investing, membrane-bone. Similar instances of suppression, not conversion, are the greater portion of Meckel's cartilage, the premaxillæ and maxillæ, probably the palatine and quadrato-jugal bones of Birds and Mammals, and to a great extent the mammalian quadrate through its conversion into the os tympanicum. On the other hand, the human clavicle surrounds, and is intermixed with, the precoracoid cartilage.

The next points of importance considered by Nitsche are the composition and shedding of the horny sheaths of *Antilocapra*, which he does not homologize completely with the bovine horn-sheaths. He prefers putting the Prongbuck's horns into a position intermediate between the velvet of the Giraffe and the horn of the Bovidæ. The following is his terse summary:—The



integument of the Giraffe is only hairy, that of the Prongbuck is hairy and horny, that of the Bovidae only horny. Having satisfied himself about the apophysial nature of the antlers in opposition to the epiphysial condition of the bony core of the Giraffe and Bovidae, he naturally feels justified about the complete removal of the Giraffe from the Cervidae and the fundamental difference between bovine and cervine ruminants.

These conclusions are not satisfactory. *First*, it is not likely that several fundamentally different kinds of armaments should have been developed within such a circumscribed and specialized group as the higher Ruminants or Pecora. It is of greater scientific value if we can trace all these armaments not only to the same beginning, but bring them all into one evolutionary line, so that these organs afford a clue to the phyletic development of the various groups of Ruminants. The ultimate cause of these armaments must have been the same, namely butting with the head, causing irritation, which in turn leads to hypertrophy of the cranial bones, together with the covering periost, cutis, and epidermis<sup>1</sup>.

*Secondly*, the origin of the os cornu, sometimes with a separate centre of ossification, has to be accounted for, since it is quite impermissible to assume that it was a preformed bone in the skin, which has later become fused onto the skull. Nor is there a single instance in mammalian pathology of loose ossification in the cutis due to repeated pressure or irritation, conditions which, on the contrary and invariably, lead to exostosis of the underlying already existing bone.

*Thirdly*, there is the palaeontological evidence, not very plentiful, but one fossil in hand is worth more as a proof of phyletic speculation than ever so many ontogenetic observations. Curiously enough, few palaeontologists, whilst throwing much light upon the evolution of the cervine antlers, have tried to take a broad view of the phyletic side of the whole question, and the comparative anatomists have, as usual, left the fossils severely alone.

*Lastly*, there is the Giraffe and its relation, the Okapi, the former with multiple, early appearing protuberances in both sexes, the other apparently with none.

The question at issue requires a renewed investigation of the development of the cervine and bovine armaments and a sifting of the palaeontological evidence.

### I. *Development of the Cervine Antlers.*

The first growth of a buck's antler in his first year is already a compound structure. It begins with a bulged out elevation or knob

<sup>1</sup> The general considerations and conditions have been well described and argued out by J. J. Cunningham, 'Sexual Dimorphism,' pp. 73-104. The evolution of horns and antlers, studied with due regard to the interesting physiological features, is one of the clearest demonstrations of the acquisition and inheritance of new organs, whilst any attempt to account for them (not their shape!) by variation and selection alone would be ridiculous.

of the upper lamina of the frontal bone, which forms the *pedicle*. This is a direct continuation of the frontal, identical with it in its dense, lamellar structure, numerous Haversian canals and its blood-supply, and it is covered by the same unaltered skin. It is, in fact, an exostosis or apophysial growth. On the apex of this pedicle the skin and the periost are thickened. The skin is devoid of sudoriferous glands, produces no stiff, but only very fine and soft, velvety hairs, is like them darkly pigmented and of a glabrous appearance. The cutis is in direct, intimate continuation with the periost, and contains numerous, but small vessels, chiefly lymphatic, and only capillaries perforate the periost.

Immediately beneath it follows a dense layer of hyaline cartilage, which, together with rapidly proliferating connective tissue, makes up the apical portion of the pedicle and forms the growing point of the future pricket. Vertical sections through the growing pricket and pedicle show that the cartilage pervades the top portion in the shape of strands, trabeculae, and walls, which partition off equally proliferating masses of ingrowing connective tissue in which turn up bone-forming cells. The bulk of this ingrowing tissue comes in with the vessels which extend from the interior of the pedicle upwards into the base of the soft mass on the top; little connective tissue enters together with the small vessels of the periost. The process of ossification begins at the base and near the periost, pervading the whole growth in the shape of a very irregular framework, without forming concentric bone-lamellae and with but few Haversian canals.

The first prickets or broaches are short-lived; they are shed in the middle, or even earlier, of the first winter. The shedding of a full-grown antler has always rightly been referred to necrosis, but it is a rather complicated process. To begin with, the antler continues to ripen, or to harden, by the deposition of bone in the more spongy, axial centre, long after the velvet has been frayed off, the loss of which is consequently not the only, nor the main cause of the decay of the antler. The latter is nourished not only by the big vessels (branches of the temporal artery) which, ascending in the skin and periost, cause the "gutters," but also by the numerous vessels which ascend through the pedicle into the interior of the antler. The base of the latter, where it passes into the pedicle, becomes much denser and harder, instead of remaining somewhat spongy in the core, and the blood-supply is stopped. About the same time, at a level *below* this junction, *i. e.* within the top portion of the pedicle itself, the Haversian canals are widened owing to activity of osteoclasts, and they become confluent into a "resorption-sinus." This is met by a ring-shaped furrow, which eats its way from the periost inwards. The hardened base of the antler is slightly convex, while the resorption-sinus forms a somewhat deeper cup on the top of the pedicle. Owing to this mode of resorption, which always affects the pedicle, this becomes lower every year, but it makes up for this loss by broadening. Long pedicles are consequently the older

stage, both onto- and phylogenetically. The cup is filled with lymph, some oozing-out blood-clots and a rapidly increasing mass of proliferating cells which are granulating from the walls of the cup. This mass is soon, within a day or two, covered over by a thin network of epidermal and connective tissue proceeding concentrically from the edges of the skin, which arises in the shape of a thickened ring-wall. Large vessels, branches of the temporal artery and facial vein, accompanied by branches of the facial and trigeminal nerves, ascend in the much-thickened cutis which covers the whole growth. These big vessels send only very fine branches into the antler, and they soon become capillary. These seem to anastomose with the terminal capillaries of the vessels which ascend within the antler. Owing to this arrangement, the outer portions of the antler receive more calcareous salts than the inner parts. They are denser, more opaque, and harder. Ossification of the whole soft and spongy mass proceeds from the base and periphery upwards.

It is important to note that the preparatory process of shedding follows immediately upon the time of greatest exhaustion, *i. e.* after the rutting-season, and that the beginning of the new growth does not coincide with the awakening of sexual activity. Herewith harmonizes the fact that adult stags, when castrated, shed their antlers within a few weeks, whereupon a new growth is formed, which, however, continues to grow throughout life, resulting in abnormal, more or less monstrous antlers.

It is assumed generally that the fraying of the velvet has originated through fighting, that the bared portion of the antler-bone became necrotic, and had therefore to be renewed &c., and that the whole process of stripping, necrotising, shedding, and renewing has become rhythmical—a feature due to cumulative inheritance. This may be the case. But there is another consideration. There would be no reason why antlers and velvet should not grow continually, and mend or rebuild injured or lost portions like other parts of the body, unless there occurs a diversion or stopping of the energy and supply of building-up material. Such a diversion is actually caused by the awakening of the sexual glands. They are the important organs, and all the energy and supply (which after all have their limit) not necessary for the keeping up of the body and life of the animal are concentrated upon the generative system, while nothing can be spared for the further growth of secondary exuberances. Therefore the blood-pressure in the head is diminished, the supply of the skin covering the antler gradually ceases, and the velvet itself becomes necrotic, from the apex downwards.

## II. *Development of the Bovine "Horns."*

The bovine or antelope "horn" is, as a rule, described as consisting of a bony core, itself an outgrowth of the frontal bone, and the horny sheath. In reality it corresponds exactly in growth

and composition with the pedicle and antler of the *Cervinae*. The homologue of the antler has, since Sandifort, been called the *os cornu*, and it forms by far the greater mass of the whole bony cone. It has already been stated that it is continuous with the pedicle, so much so that in many species of *Cavicornia*, especially of *Oxen*, the sinuses of the diploë extend far into the cone, in old animals far towards the apex. Occasionally the *os cornu* ossifies from a special centre, separate from the frontal bone. It is, however, short-lived as a separate entity. A. Brandt found it in lambs as a small bony nodule, which could be lifted out of a corresponding cup-shaped depression of the frontal bone in very young animals. It fuses with the rest when the lamb's horns are perhaps 3 cm. long. Nitsche found it in the kid of a Chamois whose horn-sheath was only 2 cm. long, and he adds that it is already firmly fused with the frontal bone in the first autumn. I myself have several times come across specimens of ewe-skulls which had been bleaching for a long time on the Welsh hills, and in which the upper lamina of the frontal bone had fallen off at the precise spot which normally carries the horns. There is no pedicle in these specimens, but this absence is due to the feebly developed state of the horns of these ewes, which as a rule do not carry such organs. In calves, even the youngest, a separate *os cornu* is unknown, but they occur sometimes, pathologically, in polled or hornless cattle as ever-growing bone loosely attached to the head by the surrounding skin. It is a great mistake to imagine that the occasional separate ossification of the *os cornu* is a primitive feature.

The normal development of the calf's head-gear is as follows :—Slight elevation of the frontal bone into a comparatively broad-based but low pedicle. This is surmounted by a shallow cone composed of fibrous connective-tissue and cartilage. The cartilage has its growing-point near the apex. The perisclerium is continuous with the periost of the pedicle portion. Ossification proceeds from the pedicle upwards, transforming the soft growth into a bony cone, the cartilage being gradually restricted to the apex. The last traces of cartilage vanish when the horns are between one and two inches in length, and the *os cornu* then continues to grow by the ordinary subperiosteal mode, young connective-tissue continuing to proliferate especially at the apex. Blood-vessels enter from the pedicle and from the periosteum. The periosteum passes imperceptibly into the rest of the cutis. Vertical sections of a young "horn" half an inch in length show all the minutest features in diagrammatic clearness. The specimens were decalcified in picric and nitric acid, then cut and stained with the triple stain of Erlich-Biondi, with hæmatoxylin and picric acid, or with thyanine.

Outside is the dense mantle of horn passing towards the Malpighian layer into the characteristic comb-shaped jagged processes in the act of transformation into horn, each of the processes resting upon a finger-shaped extension of a cutis-papilla.



Below and between them are numerous hairs, some of which reach the surface and are imbedded in the horny mass, others are hemmed in and suppressed.

The rest is best explained by a diagram. The important point is that the cartilage, dense and hyaline, and in active proliferation near the periost, changes further inwards into clusters of cells which show the same features and the same thyanine-staining action as the so-called muco-cartilage. Towards the strands of young connective-tissue, which becomes more prominent as we proceed inwards, the muco-cartilage cells show a breaking up of their nuclei, so that only a glassy mass remains, interspersed with débris of the cells and their nuclei. [When not decalcified, this mass is somewhat opaque and bluish owing to infiltration with calcareous salts. All this hyaline ground-substance is destroyed by giant cells which are active on the margin and a little further down. The place of the vanishing cartilage is taken up by the network of connective-tissue strands, and in this appear very active marrow-cells, and osteoblasts which build up trabeculae of bone. Consequently the cartilage is not wanted at all for the construction of the cone. This is also obvious from the fact, mentioned above, that a few months after birth the cone continues to grow long after the last trace of cartilage has vanished. The cartilage is in fact an invader of dormant scleroblast-cells in the periost, different from osteoblasts.] Concerning the horny sheath, I have to mention two important points which have hitherto escaped notice. First, the inclusion and gradual suppression of hairs by the proliferating intercrinal horn-substance. Even in old specimens of cattle-horns hairs become imbedded in the horn-sheath, which in opposition to the bone-core always exhibits basal growth. Secondly, the fact that calves, when several months old, shed the first juvenile hornshoe. This is not always cast off in one piece; it may be frayed off, but this is a process very different from the incessant wear and tear of the permanent horn-sheath of the adult. The shed portion so to speak, the first generation of the horn, is more porous, less solid than the permanent horn, from the base of which it becomes separated to the extent of several centimetres, as shown in the illustration (text-fig. 25, p. 216). The whole process recalls the relation of the neosoptile to the teleoptile or permanent feather, and still more the shedding of our own foetal finger-nails.

### III. *Antilocapra*.

Not much more is known about the development of the Prong-buck's horns than what Forbes and, recently, Nitsche have described. Nitsche has shown that the sheath is an aggregation of sparse hairs connected by much "intercrinal" horn-substance, the whole process resembling somewhat the pathological ichthyosis of calves. He has also shown that the prong is formed entirely by the horn-sheath, and that there is no corresponding outgrowth

on the bone-core. Forbes remarked that in his specimen "the prong is not yet visible, but may be felt at the base of the pedicel, close to the skull, on the anterior margin of the horn." (*Cf.* text-fig. 25, III<sup>2</sup>.) In well-macerated specimens in the Cambridge Museum, the difference between the rather long pedicle and the decidedly short os cornu proper is well marked. Owing to the continued and active growth of the shoe from the base, the axial point and the prong are gradually pushed upwards, so that the prong comes to lie far above the skull in a level even above the base of the os cornu, which in the adult is thinned out into a non-osseous, tapering, string-like cone of soft connective-tissue and periost. The shoe continues to grow basally, and ultimately engulfs not only the os cornu but also nearly the whole pedicle.

#### IV. *The Giraffe and the Okapi.*

It is of no importance to the present investigation whether the few hitherto known skulls of the Okapi are those of young or adult males or females. The skulls exhibit the same tendency towards broad-based swellings on the fronto-parietal and facial regions as in the Giraffe. Even in the latter genus these parts, although slight and bulging, owing to the pneumatic condition of the bones of such a weakly constructed skull, can ill be reconciled with the only reasonable explanation of the genesis of horns and antlers. We have to assume that the ancestors of the Giraffe had stronger skulls, with serviceable antlers, and that these armaments have caused the bosses of the supporting bones, and that in the Giraffe these very armaments have degenerated into now merely ornamental remnants, vanished in the Okapi. It is possible, as Mr Thomas has sagaciously suggested, that the degeneration of these armaments is correlated with the lengthening of the fore-limbs and neck, the animals ceasing to fight with their heads and using the powerful fore-limbs instead. This applies obviously to the Giraffe, but not so easily to the Okapi, unless we look upon the latter as the most degraded descendant of the whole group, which, although perhaps never numerous, was certainly more widely distributed in the shape of several genera and species. At any rate, the Okapi represents not the beginning, but the most modern and most modest member of a tribe which has flourished in bygone times.

There are other proofs that the Giraffe's armaments represent no primitive condition. The bony growths appear loosely in the skin, a condition which finds a parallel in the cases of separate ossification of the os cornu of certain *Bovinae*. Their matrix has become so emancipated from the skull, that they shift their position before fusing onto the cranium, and their mode of fusion is most peculiar. As Mr. Thomas has expressed it graphically, not only at the base of the growth, but around it, and quite irregularly, there appear little bony nodules, which become amalgamated with the cranium as if wax had been dropped upon it. Such numerous, small and irregularly scattered "osteoderms"

are not primitive, they are the expression of degeneration, of the breaking up of a once powerfully developed bony growth.

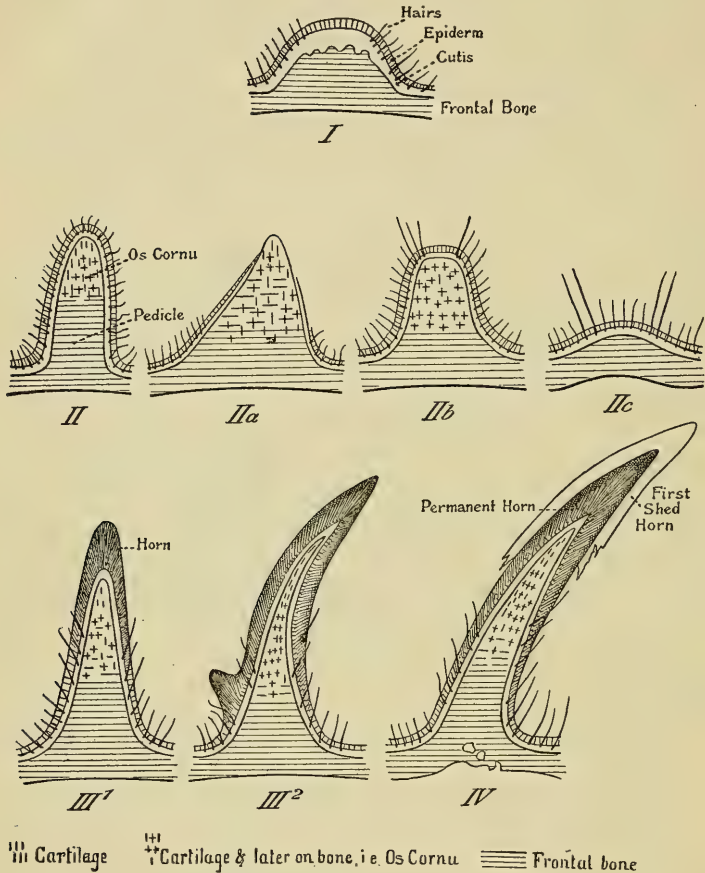
Fossil Giraffe-skulls are unfortunately still unknown, but *Samotherium* with frontal and posterior protuberances, *Sivatherium* with posterior growths hollow at the base and with frontal growths, lastly *Brahmathorium* with posterior and frontal armaments, are undoubtedly allied to the Giraffoid stock. We leave out the unarmed *Hydaspitherium* and *Helladotherium*, which are suspected by experts to be female *Sivatheria*. It has been questioned whether these armaments, huge, and sometimes branched, were covered with skin and hair, or with horny sheaths. The antlers of the original specimen of the male *Sivatherium* clearly show deep and strong impressions of the blood-vessels, extending almost to the tips exactly as in Cervine antlers. They were undoubtedly covered with skin, and it would be hardly fair to assume that this and similar specimens happened to have died in the velvet stage. The same applies to *Samotherium boissieri*. But it does not follow that these armaments were true antlers in the sense that they were shed. Dr. Forsyth Major is inclined to think that there are sutures between them and their base. If there are any, they simply indicate the line of transition or demarcation which is usually seen between the pedicle and the rest. The hindmost pair of armaments of *Sivatherium* are hollow at the base, a fact which speaks decidedly against periodical shedding; and the broadness of the base supports this view, since a good and permanent vascular supply from below was thereby ensured. The much shortened shape of the skulls of *Sivatherium* and *Brahmathorium* are unmistakable signs of specialization, excluding the possibility that these huge creatures of the latest Miocene or lowest Pliocene were the direct ancestors of Giraffes; but they were near relations and contemporaries.

We are now able to conclude that the evolution of Horns and Antlers and similar cranial armaments has passed through the following stages:—

- I. Exostosis. Subperiosteal ostotic outgrowths of the cranial bones, covered presumably with thickened skin-pads. These armaments were multiple, occurring on various parts of the skull. This type is rather old among the Ungulata, witness the Eocene Amblypoda, e. g. *Dinoceras*. It reoccurs amongst the Artiodactyla, which here alone concern us. *Protoceras* of the Lower Miocene of Montana is an almost ideal type in this respect, with its three or four pairs of facial, orbital, and posterior bony excrescences in the shape of uncouth ridges and neat cones. (Text-fig. 25, I, p. 216)
- II. Exostosis of the frontal bone producing a *pedicle*, with epichondrosis of apical growth, which by subsequent basal ossification becomes the antler. Skin originally unaltered, hairy; this and the chondrosteoma are shed periodically.—*Cervine type*. (Text-fig. 25, II, p. 216)

These stages are repeated by every young Cervine male. A portion of the integument is frayed off, at first perhaps accidentally, then repeatedly during the annual rutting-time, and a

Text-fig. 25.



Evolution of Horns and Antlers.

- I. *Protoceras*.
- II. Young Stag, with velvet.
- II a. *Sivatherium*.
- II b. Giraffe.
- II c. Okapi.

- III¹. *Antilocapra*, adult; early stage.
- III². " " ; later stage, when the prong begins to grow.
- IV. Domestic Calf.

rhythm of regeneration is established. The regeneration naturally concerns chiefly the additional chondro-osseous apical portion, this being the distal and therefore more easily injured part. But



originally, as still shown by the mode of growth of the youngest stage, no hard-and-fast line can be drawn between antler and pedicle, and even now in recent species part of the *bona fide* pedicle itself (*i. e.*, that part which is not infiltrated with cartilage) is annually destroyed and regenerated, although not "shed."

It is safe to presume that the earliest *Cervine* had long pedicles and short antlers, or rather prickets and broaches. The further development into long and branched antlers is an instance of the morphologically and pathologically well-known fact that organs which are originally due to hypertrophic causes are liable to grow to excess. There is no maximum limit to the size of antlers and to the number of tines in the Stag, although old individuals are liable to "decline."

The earliest typically *Cervine* creatures are referred to the genus *Palæomeryx*. The somewhat mixed synonymy of genera and species has to a great extent been unravelled by Roerig, who has described and figured every known specimen. Finality is, however, impossible until we know for certain whether the separately found pedicles and antlers, or both together, are successive stages of one species, or represent the armaments of several adult species, or genera, which did not pass beyond the respective stages of broachers, forkers, &c.

Two frontal pedicles and two pedicles with simple, low, spiked antler-fragments are known from the Lower Miocene of Hessler. They show already a slight burr, proof that the tips were shed. Roerig, assuming that these fragments and the following specimens form the successive stages or "heads" of one and the same species, refers them to *Dicrocerus furcatus*.

The second stage, or "head," is represented by typical broaches, with a distinct little burr, from the *Dinotherium*-sands. They are referred by Roerig to *D. furcatus*, second stage or head, equivalent to *D. elegans* of Lartet = *D. dicranocerus* of Kaup.

The third stage, or head, with a thick, somewhat compressed antler ending in a short fork, is *D. furcatus* from Steinheim, Mid-Miocene. Another specimen, from the same locality, has a deeper fork and a thicker burr—*D. furcatus*, fourth head. The burr, not sharply marked off, but rather a thick swelling, bears a striking resemblance to a specimen of an immature *Antilocapra* in the Cambridge Museum. The bony fork of course excludes any further resemblance and affinity.

The last stage, with a gracefully forked long antler, with typical burr upon the still long pedicle, is represented by *D. elegans* from Sansan, Mid-Miocene; it is possibly the final lead of *D. furcatus*: synonymous with *Procervulus* Gaudry, *Micro-meryx* Lartet? The Neotropical *Subulo* s. *Coassus* e. g. *C. rufus* still remains in the broacher stage; and *Cervulus*, the Muntjac, is an incipient forker. *Hydropotes inermis* alone, of China, has no outgrowth whatever.

The possession of deciduous, large, many-branched antlers amounts to an enormous waste of energy and material during the

life of the owner. Although full of grace and beauty, antlers are morphologically very faulty structures, as wastefully contrived as the shedding of the thousands of teeth of Sharks and Crocodiles. The long duration of the growth of the antlers, their soft and highly sensitive condition during this time, is even a distinct trouble, not to say danger, a circumstance which shows clearly that these organs are not primarily weapons to be used against other species.

II *a*. A side issue from II. Epichondrotic growths preponderant, with multiple and broadened bases. Ossification delayed but still proceeding from base. Cranial exostoses or pedicles correspondingly reduced. These weapons with an increasing tendency of intraperiosteal growth reached a large size in width and length, and remained permanent structures. The tips of the orbital and posterior pair of weapons may have been covered with thickening epiderm, more or less hairy; the bulk of the growth was permanently covered with the unaltered hairy skin. It is possible that this protecting cover and the tips of the bony core were worn off without impairing the fighting use of these massive structures, which need not die off thanks to the remaining velvet, or (even if this was ultimately lost) thanks to the unimpaired vascular supply from the interior of the broadened base. Creatures thus armed reached their culmination in the huge *Sivatherium* and *Brahmatherium*. (Text-fig. 25, II *a*, p. 216.)

Here we have to confess the existence of a painful gap and a vagueness in connecting this type II *a* with others of the main line. This difficulty will remain until fossil ancestors of these creatures are found. That they form a side issue is obvious enough. So far as the few actually known genera are concerned, they are of the latest Miocene, perhaps of the lowest Pliocene date, anyhow considerably younger than *bona fide* Cervinæ which we can trace back into Lower Miocene. In this respect, and by the morphological agreement between the stalked posterior antlers of *Brahmatherium* with pedicle and antler of an early Stag, we are justified in looking upon this type II *a* as a side-branch of the main type II. On the other hand, the prevalence of multiple outgrowth, facial, orbital, parietal, and generically variable, might rightly be urged as a primitive feature, resembling in this respect type I, so that the *Sivatherium* type would form a side issue somewhere between I and II. However, it must be borne in mind that multiple pairs of such weapons crop up pathologically in recent Cervidæ, and normally even in the Antilopine *Tetraceras*—facts which nobody can possibly consider as primary. Consequently the multiple armaments of the Progiraffine creatures are not absolutely an indication of their great phyletic age and low position.

- II *b*. Terminal, further development of type II *a*. Epichondrotic growths proliferating freely and with broad bases, so that they form intraperiosteal growths, separated from the cranial bones, and consequently ossifying independently of them, ultimately fusing with them. Cranial apophyses or exostoses, or pedicles, much reduced in height. Disuse of the outgrowths, implying cessation of the irritation upon the basal periost (*i. e.* between the growth and the cranial bone), explains diminution of the pedicles and their late fusion and the long delayed process of ossification. But the development of the echondrotic mass, inherited from the ancestral stock, and subsequent ossification still go on, although without a purpose, and they produce organs which, owing to their late fusion with the cranium, their original home, now appear as osteoderms, although in reality they are pseudo-primitive organs. The integument remains hairy, except on the top where the epiderm proliferates and cornifies a little. Example, the *Giraffe*. (Text-fig. 25, II *b*.)
- II *c*. Apparent loss of all these armaments, the last remnants being frontal bosses: *Okapi*. (Text-fig. 25, II *c*, p. 216.)

It is worth noting that, while the females of *Sivatherium* and *Samotherium* are, by general consent, not credited with "antlers," the Giraffe makes an exception in this respect. This fits in with the view, expressed in this paper, that Giraffes represent a terminus of one line of development. There are some typical *Cervinae* of which both sexes are antlered. The acquisition of secondary sexual organs by the females is mainly a question of time. It is an illustration of simple, direct inheritance from the other sex, so common in organs which are connected with sexual activity, *e. g.* clitoris, mammae, spurs. These things are of not the slightest good to their new possessors, but they do no harm either. They are therefore neglected, rather not discovered, by natural selection.

- III. The same initial stage as type II. A long pedicle with a simple broach, covered with hairy skin, but the epidermal portion of this tegumentary sheath proliferates, glues the hairs together and embeds them. The horny sheath is an efficient protection against injury; the external or cutaneous and the internal vascular supply remain, and the simple antler is shed no longer. Immature specimens still show a thickened, burr-like swelling at the juncture of the pedicle and antler. We assume that the horn-sheath consisted originally of an imperfectly welded material still liable to fraying, until it became effective enough to prevent any necrosis and subsequent shedding of the antler, which thereby becomes an *os cornu*. So long as the hair preponderates in the deeper strata, the shedding and

renewal of the hairy coat is likewise repeated by the horny sheath. This stage is still represented by *Antilocapra*, although the horny sheath by continued basal growth gradually envelops also the greater part of the pedicle. (Text-fig. 25, III, p. 216.)

- IV. Direct continuation of types II and III, still repeated stage by stage ontogenetically. An improvement towards the preponderance of the intercrinal horn-substance, the conversion of the sheath into a morphologically well-finished horn-sheath, the suppression of the hairs, and of periodical shedding of any part of the whole compound weapon, was only a question of time with onward evolution. This, the highest and most perfect stage, is represented by the typical *Antelopine* or *Bovine* Ruminants, of which their peculiar member, the Prongbuck, still falls short. They are morphologically the highest, palæontologically the latest of Ruminants. Herewith it agrees that horns are carried by both sexes, whilst the inheritance of these organs by the females is still a rare exception amongst the *Cervinæ*. Moreover, these weapons, having become permanent and evergrowing, and therefore useful throughout the year, are of much greater value to their bearers. (Text-fig. 25, IV, p. 216.)

Attention has already been drawn in this paper to the important fact that the horns of a young calf still contain a considerable number of hairs mixed up in the sheath, and that in older animals such hairs are restricted to the more basal portions; secondly, that the top cone of the hornshoe is shed. In Ewes this first generation falls off as a thin, transparent cap of the size and shape of half a hazel-nut. In fact this first cap of the Bovine horn is in every respect homologous with the shedding sheath of the Prongbuck. The Oxen, Sheep, and Goats now exhibit only once a process of shedding which in their immediate ancestors must have been of frequent occurrence, and which in the Prongbuck is still a periodical feature.

The types I, II, III, and IV, exemplified by the Eocene *Dinoceras*, the *Cervinæ* since the Lower Miocene, the Prongbuck, still existing, and the hollow-horned Ruminants or *Bovinæ*, are an illustration of onward phyletic evolution; and these stages are still faithfully repeated in the development of the recent species. Ontogeny is a shortened recapitulation of phylogeny.

*Titles of the more important Literature referred to in the text.*

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- NITSCHKE, H. Studien über Hirsche. Pt. I. Leipzig, 1898.
- ROERIG, A. Ueber Geweihentwicklung und Geweihbildung. Arch. f. Entwickl. Mechanik, x. (1900), pp. 525–644, pls. xii.–xiii.; xi. (1901), pp. 65–148, pp. 225–309. [Numerous drawings of antlers, both normal and abnormal; with a complete list of the literature and a historical review of the whole subject, but he, as well as Brandt and Nitsche, have restricted themselves practically to macroscopic features.]

Important from a general point of view are also:—

- SIR VICTOR BROOKE. On the Classification of the Cervidæ. . . P. Z. S. 1878, pp. 883–928.
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- CUNNINGHAM, J. T. Sexual Dimorphism in the Animal Kingdom. London, 1900.

P.S.—On the day this paper was read Dr. Forsyth Major gave me intelligence of a paper by Dr. J. Ulrich Dürst. A copy of his “Versuch einer Entwicklungsgeschichte der Hoerner der Cavicornia nach Untersuchungen am Hausrinde” [Forschungen auf dem Gebiete der Landwirthschaft, Frauenfeld, 1902] reached me on March 24th. The author has also observed the shedding of the first horn-sheath; he likewise correctly states

that the budding growth of the bone-core differs in structure and mode of development from the frontal bone proper, but he emphatically doubts the temporary separate existence of the os cornu, and he feels satisfied that it is not formed by the intervention of cartilage, since the substance in question was not coloured blue by hæmatoxylin staining. He and others will have to accustom themselves to the existence of cartilage in places where text-books carefully abstain from mentioning it.

## 2. On a new Stridulating-Organ in a Scorpion.

By R. I. POČOCK, F.Z.S.

[Received February 25, 1902.]

(Text-figure 26.)

Stridulating-organs have been found in three genera of Scorpions, viz., the large species of the Oriental Region and Tropical Africa referred to *Palamnceus* and *Pandinus*, and the South-African members of an allied form *Opisthophthalmus*<sup>1</sup>. In the two first-named the organ lies between the basal segments of the chelæ and of the legs of the first pair; in the latter between the inner surfaces of the mandibles or their upper edge and the front border of the carapace. In all three cases it consists in the main of peculiarly modified bristles. No organ of similar function has as yet been discovered in any other family of Scorpions. But in the Buthoid genus known as *Parabuthus*, which ranges from the shores of the Red Sea to Cape Colony, I find a stridulator (text-fig. 26, A & B, p. 223) differing entirely both in structure and position from that of the Scorpions above mentioned.

It has long been known that the upper sides of the proximal segments of the tail in *Parabuthus* are furnished in the middle with an aggregation of granules, so fine and close-set as to be appropriately comparable to shagreen. The granules are sometimes thickest and coarsest in the median groove, but finer and more scattered at the periphery of the area; sometimes of uniform strength throughout: sometimes they are confined to the median groove; sometimes, and more often, they encroach upon the adjacent area of the surface that bears them.

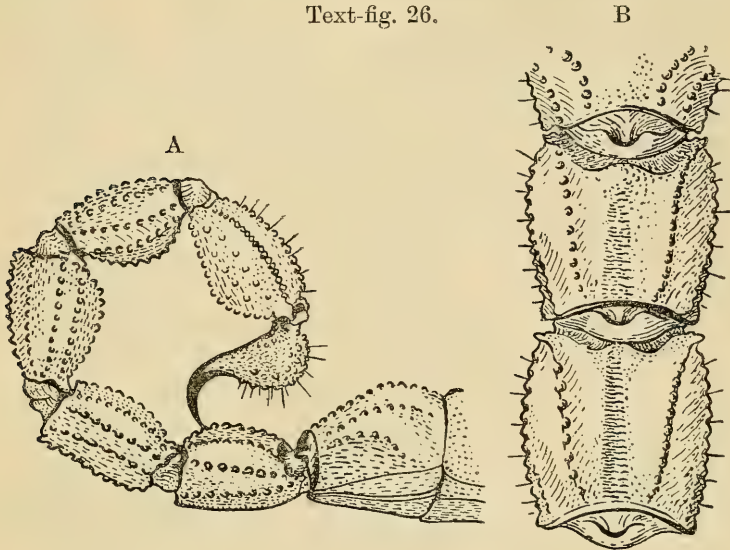
Of the species known to me, the granulation reaches its highest point of development in *Parabuthus flavidus* Poc., where the granules have run together across the middle line to form short parallel transverse ridges with their free edges directed backwards (text-fig. 26 B).

The surface that bears this granulation also differs in formation according to the species. In the more northern and less specialized forms—such as *P. liosoma*, *P. abyssinicus*, *P. hunteri*, *P. granimanus*, and *P. heterurus*—the area in question is but little modified, remaining normally depressed and grooved in the

<sup>1</sup> Pocock, Nat. Science, ix. pp. 17-25 (1896), and Ann. Mag. Nat. Hist. (6) xviii. pp. 75-77 (1896).

middle line; but in many of the southern types—e. g., *P. planimanus*, *P. neglectus*, *P. villosus*—the whole upper surface of the segments tends to become flattened and horizontal both in a longitudinal and transverse direction. A similar granular field is developed between the dorsal keels on the last abdominal tergite.

Text-fig. 26.

Stridulating-organ of *Parabuthus flavidus*.

- A. Lateral view of tail, to show the action of the sting during stridulation.  
 B. Dorsal view of last somite of abdomen and of 1st and 2nd caudal segments, showing the ridges on the median groove of the two segments.

If the tail of one of these Scorpions be brought into the attitude usually assumed by these animals when striking, and the point of the sting be scraped over the granular field, a very distinct sound is emitted, resembling that produced by drawing the point of a needle over fine sand-paper<sup>1</sup>.

There is as yet no direct evidence, based on observation of the living animal, to prove beyond dispute that these granules have the function here assigned to them, but the facts which support the conclusion are the following:—

(1) The sound can be artificially produced, and is audible to me at a distance of ten yards or more.

(2) The scorpion itself is capable of performing all the movements necessary for its production.

<sup>1</sup> A similar but less complete development of granules, subserving no doubt the same purpose, is observable in two North-African species of *Buthus*—*B. bicolor* and *B. aeneas*.

(2) The granules are especially well-developed upon the first and second caudal segments and upon the last abdominal tergite, against all of which the point of the sting can be forcibly scraped. On the third caudal segment, upon which the sting is capable of but little movement, they are scarcely or not at all developed, and upon the fourth and fifth, which cannot be touched by the point of the sting, they are absent.

(4) The longitudinal flatness of the granular area on the first and second caudal segments, which results from the uprising of the groove and the elevation of the anterior part of the upper surface, can be explained on the supposition that it is designed to give the sting a long and continuous sweep from segment to segment, without the danger of catching against their posterior edges or of wounding the arthroal membrane. It is difficult to see what other interpretation is to be put upon this special and unique modification of the segments in question.

### 3. On the Organ of Jacobson in the Elephant-Shrew (*Macroscelides proboscideus*). By R. BROOM, M.D., B.Sc.<sup>1</sup>

[Received February 4, 1902.]

(Plate XXI.<sup>2</sup>)

From the examination of the organ<sup>3</sup> of Jacobson in a large series of mammals, I, in 1897, concluded that it varies surprisingly little in even very dissimilar genera of a common Order. In the Marsupialia the chief Polyprotodont genera have their organ of Jacobson very much alike, while even in the Diprotodonts the organs are all formed on a type which differs but little from that found in the Polyprotodonts. While in all the Rodents, so far as examined, the organ is formed on a single peculiar type which seems to be a modification of that found in the Marsupials, in the higher mammals a single type of organ is found in forms so varied as the Hedgehog, Bat, Lemur, Cat, Sheep, and Pig.

It would thus appear that the organ of Jacobson is but little influenced by the habits of the animal, that it remains a clear indicator of the early family relationships of a genus when almost all the other ancestral characters have been so modified as to be scarcely recognizable, and that hence it is of considerable importance in determining the precise affinities of aberrant mammals.

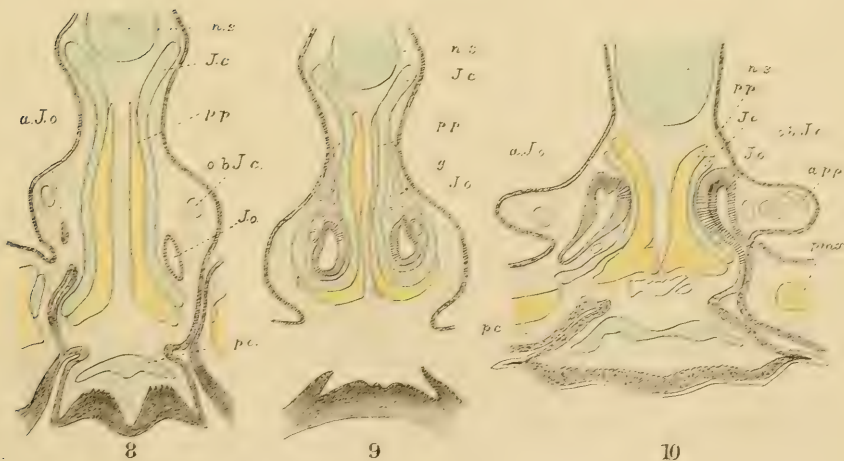
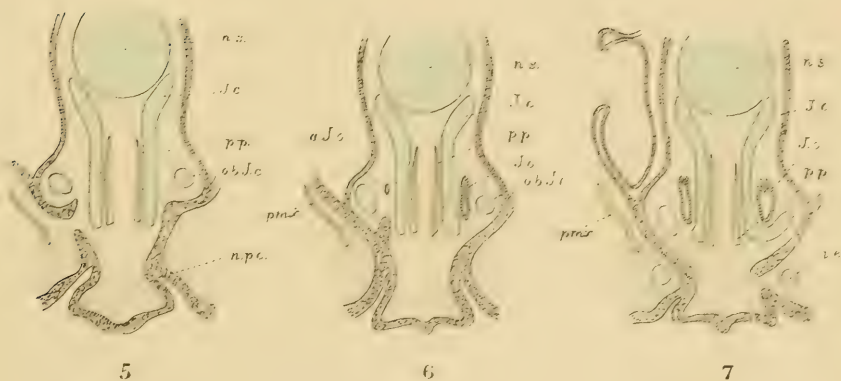
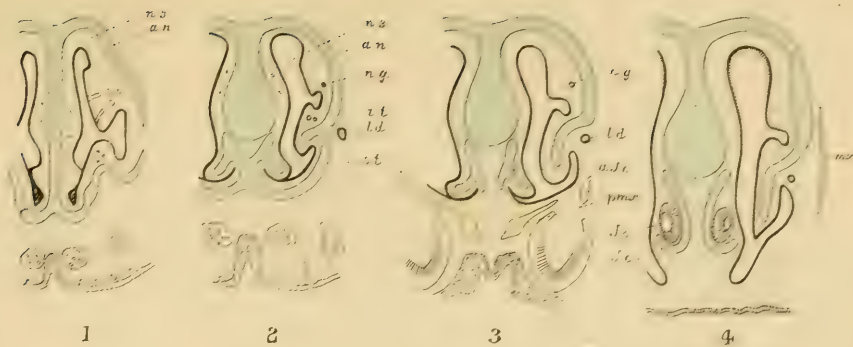
Having recently had occasion to make a series of sections of the snout of a foetal Elephant-Shrew (*Macroscelides proboscideus*), in connection with a study of the development of the palatine process of the premaxilla, I was naturally much interested in observing the condition of Jacobson's organ, especially as W. K.

<sup>1</sup> Communicated by Prof. G. B. HOWES, F.R.S.

<sup>2</sup> For explanation of the Plate, see p. 227.

<sup>3</sup> Trans. R. Soc. Edinb. vol. xxxix. p. 234.





EB del.  
M.F. Parker lith.

Parker & West imp.

JACOBSON'S ORGAN IN MACROSCELIDES.



Parker has shown that in the allied genera *Petrodromus* and *Rhynchocyon* there are a considerable number of Marsupial characters. In the Hedgehog the organ is formed on the common Eutherian type, and I expected to find in *Macroscelides* indications of marsupial affinity. When the organ was investigated, however, it was seen to be quite different from that in any Eutherian hitherto examined, and to be typically Marsupial in almost every respect.

Before entering upon comparative observations, it will be convenient first to describe the condition of parts in *Macroscelides*.

If a section be made near the middle of the proboscis, it will be seen (Pl. XXI. fig. 2) to be formed of a ring of cartilage (*a.n.*), enclosing the two nasal passages and surrounded by soft tissues—muscles, tendons, and skin. The skeletal portion is made up of a well-developed median nasal septum (*n.s.*) and two alinasals (*a.n.*), which sweep round from the upper end of the septum and meet each other inferiorly. From this lower point of union of the alinasals they pass upwards to meet the lower end of the septum. From the inner side of each alinasal, near the level of the base of the septum, there passes inwards a small turbinal which is an anterior continuation of the inferior nasal turbinal; and from the point where the incurved end of each alinasal meets the base of the septum there passes downwards and outwards a second turbinal plate which may be referred to as the *septal turbinal* (*s.t.*). With very little modification, this description might refer to any section of the proboscis. On approaching the anterior end (Pl. XXI. fig. 1), however, the turbinals are found to be less developed, the nasal septum slender and fused with the alinasals inferiorly, and the upper half of the alinasals to be separated from the lower. Near the anterior nasal opening a transverse section shows a pair of alinasals above, a pair of cartilages on the nasal floor, and a pair of rather complicated lateral cartilages which apparently form nasal valves. The anterior nasal opening looks outwards and slightly downwards.

In a transverse section near the root of the proboscis, the only noteworthy differences from the more anterior sections are that the base of the septum is considerably larger, while the lower halves of the alinasals are not only separate from each other, but are distinct from the alinasals above—forming nasal-floor cartilages.

When the plane of the premaxilla is reached (Pl. XXI. fig. 3), the outer and lower part of the nasal-floor cartilage becomes lost, only the part situated immediately below the base of the septum and which forms the septal turbinal remaining.

A few sections in front of the plane where the palatine process is given off from the premaxilla, the premaxilla (*pmx.*) sends upwards a narrow plate as a support to the inner side of each of the two cartilages which lie at the base of the septum. These plates form the anterior ends of the palatine processes (*p.p.*). About this same plane the small cartilaginous plates, which in the

more anterior sections have been seen to form the septal turbinals, become detached from the inner plates.

A section immediately behind the anterior end of the palatine process shows the inner plate of the nasal-floor cartilage dipping down in the cleft between the palatine process and the premaxilla, supported on its inner side by the vertical plate of the former. The papilla is fairly large, and the naso-palatine canal is seen passing upwards and inwards by its side.

A few sections beyond this plane we see (Pl. XXI. figs. 5 & 6) that the naso-palatine canal (*n.p.c.*) on passing further upwards turns outwards as it opens into the nasal cavity. On its upward passage it receives the duct of Jacobson's organ (*J.o.*). This duct, which lies almost vertically, passes between the large vertical plate and the apparently detached outer portion of the nasal-floor cartilage and opens into Jacobson's organ near its anterior end. The organ extends very slightly in front of the point where the duct is given off.

Immediately behind the duct (Pl. XXI. fig. 7), the lower end of the vertical plate becomes attached to the outer, apparently detached, portion, forming a floor to the organ. It will thus be seen that Jacobson's cartilage has an outer bar exactly as in Marsupials.

The Jacobson's organ itself is of moderate length and presents no features of special interest in the fetus. The posterior part of it appears to be devoid of sensory epithelium and to be merely the duct conveying the secretion from a large number of glands.

In the adult, the cartilages are essentially similar in arrangement to those in the fetus, but an additional feature is to be observed in the presence of a well-developed cartilage in the papilla (Pl. XXI. fig. 8). The organ is in section (Pl. XXI. fig. 9) somewhat kidney-shaped, with a single large vessel running along the hilus. The sensory epithelium is confined to the inner wall, and the organ is abundantly supplied with glands (*g.*).

From the above description it will be seen that in its relations the organ has little or no resemblance to the highly specialized type met with in most Eutherians, and that all its peculiarities are those typical of Marsupials.

In the Marsupial the following may be regarded as the most typical features of this region of the head:—(1) The Jacobson's organ opens into the naso-palatine canal near the point where the canal opens into the nasal cavity; (2) the anterior part of Jacobson's organ is protected externally by a cartilaginous bar which passes from the outer edge of the lower part of Jacobson's cartilage behind to the outer edge of the upper part in front; (3) the naso-palatine canal is never supported by a cartilaginous process from the nasal-floor cartilage; (4) the nasal floor has no cartilaginous support behind the region of the naso-palatine canal; (5) the papilla has a well-developed cartilage; and (6) the Jacobson's organ has usually a single large vessel running along its outer face.



While almost all Marsupials exhibit these features, no higher mammal hitherto examined agrees with the Marsupials in more than three of these characters. The peculiar condition of Jacobson's cartilage, whereby a cartilaginous bar is present along the outer wall of the anterior part of the organ, and which I regard as a remnant of the turbinal of Jacobson's organ retained in the Monotremes, is among the Eutheria only met with in the Edentata (*Dasypus*), and in a rudimentary condition in some Rodents. Only the Edentates again agree with the Marsupials in the absence of a cartilaginous support to the naso-palatine canal. The presence of a cartilage in the papilla, though occurring in most Marsupials, has hitherto only been observed among higher mammals in the little Bat *Miniopterus*, and possibly as a rudiment in *Cavia*.

From the fact that *Macroscelides* agrees with the Marsupials in every detail of the anatomy of this region, we are forced to the conclusion that it is a very near relative of the Marsupials, and has probably very little affinity with the more typical Insectivores. That the marsupial characters are not confined to the nose we know from Parker's work. In the tympanic region and in the remarkable condition of the orbito-sphenoid the marsupial affinities are quite as remarkable.

It is further interesting that, while *Macroscelides* in the anatomy of its anterior nasal region agrees more closely with *Perameles* than with other Marsupials, *Perameles* in one or two respects agrees more closely with *Macroscelides* than with most of the typical Marsupials. The striking similarity of structure is shown in the drawing (Plate XXI.), where a section of the anterior part of Jacobson's organ in *Perameles* is shown (Pl. XXI. fig. 10) for comparison with the section of *Macroscelides* (fig. 8).

It may be noted that *Macroscelides* has a discoidal deciduate placenta, and that the young are born in a well-developed condition.

#### EXPLANATION OF PLATE XXI.

*References.*—*a.J.c.*, anterior portion of Jacobson's cartilage; *a.J.o.*, anterior portion of Jacobson's organ; *a.n.*, alinasal; *a.p.p.*, anterior spur from palatine process; *g.*, glands; *i.c.*, small isolated cartilage—possibly a rudimentary Stenson's cartilage (not indicated in the adult); *i.t.*, inferior turbinal; *J.c.*, Jacobson's cartilage; *J.o.*, Jacobson's organ; *l.d.*, lachrymal duct; *n.g.*, nasal gland; *m.x.*, maxilla; *n.p.c.*, naso-palatine canal; *n.s.*, nasal septum; *o.b.J.c.*, outer bar of Jacobson's cartilage; *p.c.*, cartilage of papilla; *pmx.*, premaxilla; *p.p.*, its palatine process; *s.t.*, septal turbinal.

Figs. 1, 2, 3, 4. Transverse section of snout of foetal *Macroscelides proboscideus*. × 24.

Figs. 5, 6, 7. Transverse section of the same region of naso-palatine canal. × 40.

Figs. 8, 9. Transverse section of Jacobson's organ in adult *Macroscelides*. × 18.

Fig. 10. Transverse section of anterior end of Jacobson's organ in *Perameles nasuta* (young). × 17.

*Addendum* (March 1902).—While writing this paper I had taken for granted that the cranial characters described by Parker in *Rhynchocyon* and *Petrodromus* would be common to the other

genus of the family, more especially as the inter-relationship of the three genera is apparently very close; but, on looking into the structure of the skull, I find that in both *Macroscelides proboscideus* and *M. rupestris* there is a distinct optic foramen. The marsupial characters of the tympanic region are, however, as marked in *Macroscelides* as in the other genera.

4. On some Foraminifera and Ostracoda from Cocos Keeling Atoll, collected by Dr. C. W. Andrews, 1898. By FREDERICK CHAPMAN, A.L.S.,<sup>1</sup> F.R.M.S.<sup>1</sup>

[Received February 25, 1902.]

(Text-figures 27 & 28.)

On his return from Christmas Island in 1899, Dr. Andrews was good enough to submit to the writer some sands gathered between tide-marks in the Cocos Keeling Islands for examination. A casual glance at the material was sufficient to prove it worth recording, and more especially since the samples were taken both from the lagoon and from the outer side of the atoll.

Though far removed geographically, the microzoic fauna of Funafuti bears some striking analogies with the present collection, chiefly on account of the similarity of conditions in the habitats of the two faunas.

An especially noteworthy feature with regard to the gatherings now described is the frequent occurrence of the rare and occasional form *Paronina*, chiefly on the lagoon side.

With respect to the source of these samples, Dr. Andrews informs me that those from the outer reef came from a spot at some distance from the transverse channels which communicate with the lagoon. The lagoon material came from the inner margin of the reef, and it would most likely be commingled to some extent with organisms washed in through the sea-channels; but the general facies of this series, however, points to their having lived in sheltered water.

The species of Foraminifera are numerous for such a small gathering, amounting in all to 76. Some short notes are added regarding those which are of especial interest, either on account of their rarity elsewhere or their exceptional development. None of the forms appear to be actually new, but there are many peculiar modifications in form.

The Ostracoda number 28 species, and include two new forms. They are nearly all well-known littoral species, and are fairly equally distributed both inside and outside the lagoon.

#### *Notes on the Ostracoda from Cocos Island.*

The genus *Bairdia* is represented by 8 species, one or two of

<sup>1</sup> Communicated by C. DAVIES SHEEBOEN.

which have occurred in abyssal deposits, such as *B. milne-edwardsii* and *B. crosskeiana*. They are all, however, of far more frequent occurrence in shallow-water dredgings. A few of the species have a wide geographical range, as *B. milne-edwardsii*, *B. acanthigera*, and *B. crosskeiana*, which are also northern species. Of the 10 species of *Cythere* two are known from northern areas, namely, *C. prava* and *C. stimpsoni*. Another species, *C. dictyon*, is more often found in deep water, being recorded from fifteen out of twenty-five of the 'Challenger' dredgings at depths of 1000 fathoms and more. The remainder are well known from shallow-water dredgings. The genus *Loxoconcha* is represented by four species, three of which have a fairly wide range, namely, *L. alata*, *L. honoluliensis*, and *L. anomala*. There are three species of the genus *Xestoleberis*, two of which have a wide range; one of them, *X. depressa*, is also common in dredgings off the British coast, from the North Atlantic, and also as a post-Tertiary fossil from Scotland, Ireland, Norway, and Canada. The only species of *Cytheropteron* recorded here, namely *C. longicaudatum*, was originally described by Dr. G. S. Brady from material dredged in the Fiji group.

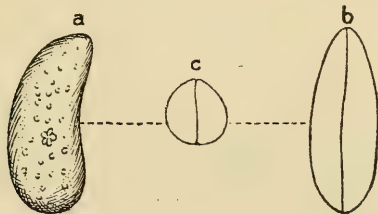
*Description of New Species of Ostracoda.*

(The specimens were not preserved sufficiently well to enable the organisms to be examined.)

CYTHERIDEIS ANDREWSI, sp. nov. (Text-fig. 27.)

Carapace suboval, elongate, somewhat arcuate and compressed. Dorsal margin, in side view, rather irregularly curved; ventral margin concave and sinuous. Anterior extremity produced;

Text-fig. 27.



*Cytherideis andrewsi*.

*a*, right valve, lateral view; *b*, edge view; *c*, end view.  $\times 42$  linear.

posterior evenly and broadly rounded. Edge view compressed ovate. End view subcircular. Surface of the carapace covered with fine pittings; and the muscle-spots in the median area disposed in rosette-form. Length .57 mm.

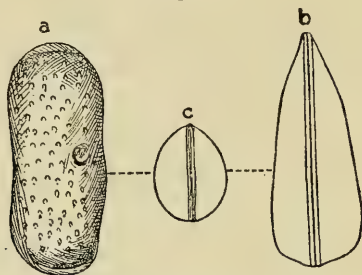
Cocos Island, lagoon; very rare.

This species differs from *C. levata* G. S. Brady in form and also in the surface-markings on the carapace itself; but it is evidently allied in some respects.

## CYTHERELLA VESICULOSA, sp. nov. (Text-fig. 28.)

Carapace subrectangular, elongate, seen from the side. Surface of carapace highest near the dorsal margin, sloping towards the ventral, with a depressed area in the middle of the valve near the ventral margin, in the lowest part of which there is a circular pit.

Text-fig. 28.

*Cytherella vesiculosa.*

*a*, right valve, lateral view; *b*, edge view; *c*, end view.  $\times 42$  linear.

Anterior part of carapace gently sloping towards the margin; posterior border steep. Edge view cuneate. End view oval. Surface of valves ornamented with numerous deeply-set pittings or cavities. Length .76 mm.

Cocos Island, lagoon; rare.

The nearest form to this handsome species seems to be *C. semitalis* G. S. Brady; but it differs in having only a part of the carapace covered with pittings, which are not, however, exactly comparable with those in our form, and the carapace itself is also shorter and stouter. The ventero-median pit is also wanting in *C. semitalis*.

*Ostracoda from Cocos Island.*

	Species.	Seaward face.	Lagoon.
1.	<i>Bairdia tenera</i> G. S. Brady .....	r.	r.
2.	" <i>ventricosa</i> G. S. B. ....	r.	.....
3.	" ? <i>acanthigera</i> G. S. B. ....	.....	r.
4.	" <i>milne-edwardsii</i> G. S. B. ....	r.	.....
5.	" <i>attenuata</i> G. S. B. ....	.....	v.r.
6.	" <i>amygdaloides</i> G. S. B. ....	.....	c.
7.	" <i>crosskeiana</i> G. S. B. ....	f.	v.c.
8.	" <i>woodwardiana</i> G. S. B. ....	.....	r.
9.	<i>Cythere scintillulata</i> G. S. B. ....	f.	.....
10.	" <i>cancellata</i> G. S. B. ....	v.r.	.....
11.	" <i>subrufa</i> G. S. B. ....	v.r.	v.r.
12.	" <i>crisatella</i> G. S. B. ....	r.	.....
13.	" <i>rastrumarginata</i> G. S. B. ....	.....	v.r.
14.	" <i>obtusulata</i> G. S. B. ....	.....	v.r.
15.	" <i>wyville-thomsoni</i> G. S. B. ....	.....	v.r.
16.	" <i>stimpsoni</i> G. S. B. ....	.....	r.

f., frequent; c., common; v.c., very common; r., rare; v.r., very rare.



*Ostracoda from Cocos Island (continued).*

	Species.	Seaward face.	Lagoon.
17.	<i>Cythere prava</i> Baird .....	v.r.	v.r.
18.	" <i>dictyon</i> G. S. B. ....	f.	c.
19.	<i>Loxococoncha alata</i> G. S. B. ....	f.	f.
20.	" <i>anomala</i> G. S. B. ....	v.r.	.....
21.	" <i>honoluluensis</i> G. S. B. ....	v.r.	.....
22.	" <i>avellana</i> G. S. B. ....	v.r.	.....
23.	<i>Xestoleberis depressa</i> G. O. Sars .....	c.	.....
24.	" <i>curta</i> G. S. B. ....	v.r.	.....
25.	" <i>margaritea</i> G. S. B. ....	.....	v.r.
26.	<i>Cytheropteron longicaudatum</i> G. S. B. ....	v.r.	v.r.
27.	<i>Cytherideis andrewsi</i> , sp. nov. ....	.....	v.r.
28.	<i>Cytherella vesiculosa</i> , sp. nov. ....	.....	r.

*Notes on the Foraminifera from Cocos Island.***MILIOLINA PARKERI** H. B. Brady.

The examples from the present locality are quite typical. In its more irregular modifications *M. parkeri* seems to pass into *M. undosa* (Karrer). The nearest locality whence *M. parkeri* was obtained previously is off Jaffa (Robertson). It is common outside the atoll, and occurs more sparingly in the lagoon. At Funafuti it was found close to the inner margin of the lagoon.

**MILIOLINA LINNÆANA** (d'Orbigny).

Among the striate forms of *Miliolina* occurring at Cocos Island the above species is worthy of remark. It is very common on the lagoon side, and the specimens are of large size and very typical. On the outer reef it is extremely rare. It does not seem to have been recorded from any dredgings previously obtained from the Indian Ocean, but is common in many coral-sands of the Pacific Ocean and the West Indies.

**MILIOLINA FUNAFUTIENSIS** Chapman.

This species, which was lately described from the lagoon of Funafuti (Ellice Islands, Pacific), occurs here in the dredgings from the outer side of the reef.

**HADDONIA MINOR** Chapman.

This is another species, occurring not unfrequently, which was first described from Funafuti.

**PAYONINA FLABELLIFORMIS** d'Orbigny.

This handsome species was for a long time after its original description by d'Orbigny almost unknown to rhizopodists, but it has of late years been recorded from several localities in the Pacific and Indian Oceans. It is noted from this particular area for the first time, and it is worthy of remark that it is found in greater abundance in the lagoon.

## GAUDRYINA BACCATA Schwager.

Some very fine specimens of this peculiar and redundant form occur in the lagoon at Cocos Island. It was not met with at all on the seaward face. The previous occurrences were noted mainly from deep water; and in this connection it may be remarked that it is not uncommon to find certain forms of Foraminifera inhabiting lagoons as well as deep water, but not in intermediate conditions of depth.

## SPIRILLINA TUBERCULO-LIMBATA Chapman.

This is a form lately found at Funafuti, which is of peculiar interest on account of its characters partaking of two of Brady's species, namely, *S. tuberculata* and *S. limbata*. It was found somewhat sparingly at Cocos Island both inside and outside the lagoon.

## GYPSINA INHÆRENS Schultze sp.

The specimens of the above form from Cocos Island are remarkable for their deep rose-colour, derived presumably from the sarcode of the animal. This colour was a distinctive feature of Schultze's original specimens. The fact of the test being so strongly tinted points to their fresh condition when collected, for they seem to lose it very easily, judging from the rarity of its occurrence. *G. inhærens* here prefers the quieter water of the lagoon, but it is also found outside.

## POLYTREMA MINIACEUM (Pallas), var. ALBA Carter.

A noteworthy feature of these gatherings was the extraordinary abundance of the white variety of the well-known *Polytrema miniaceum*. It seems restricted in its occurrence to the lagoon deposits.

*Foraminifera from Cocos Island.*

	Species.	Seaward face.	Lagoon.
1.	<i>Nubecularia bradyi</i> Millett .....	.....	v.r.
2.	<i>Biloculina oblonga</i> d'Orb. ....	v.r.	.....
3.	" <i>elongata</i> d'Orb. ....	.....	v.r.
4.	" <i>depressa</i> d'Orb. ....	v.r.	.....
5.	<i>Spiroloculina nitida</i> d'Orb. ....	v.r.	v.r.
6.	" <i>grata</i> Terq. ....	v.c.	c.
7.	" <i>impresa</i> Terq. ....	v.r.	.....
8.	<i>Miliolina circularis</i> (Born) .....	v.r.	.....
9.	" var. <i>sublineata</i> Brady .....	.....	v.r.
10.	" <i>subrotunda</i> (Montagu) .....	.....	r.
11.	" <i>labiosa</i> (d'Orb.) .....	v.r.	.....
12.	" <i>tricarinata</i> (d'Orb.), var. <i>terquemiana</i> Brady .....	c.	.....
13.	" <i>cuvieriana</i> (d'Orb.) .....	.....	f.
14.	" <i>insignis</i> Brady .....	v.r.	.....
15.	" <i>boueana</i> (d'Orb.) .....	v.r.	f.
16.	" <i>funafutiensis</i> Chapman .....	v.r.	.....
17.	" <i>linneana</i> (d'Orb.) .....	v.r.	v.c.

f., frequent; c., common; v.c., very common; r., rare; v.r., very rare.

*Foraminifera from Cocos Island (continued).*

	Species.	Seaward face.	Lagoon.
18.	<i>Miliolina ferussaci</i> (d'Orb.)	v.c.	r.
19.	" <i>bicornis</i> (W. & J.)	c.	v.r.
20.	" <i>parkeri</i> Brady	c.	f.
21.	" <i>undosa</i> (Karrer)	c.	.....
22.	" <i>seminulum</i> (Linné)	f.	f.
23.	" <i>polygona</i> (d'Orb.)	.....	c.
24.	" <i>gracilis</i> (d'Orb.)	r.	.....
25.	" <i>oblonga</i> (Montagu)	v.r.	.....
26.	" <i>transversestriata</i> Brady	v.r.	.....
27.	<i>Planispirina exigua</i> Brady	v.r.	.....
28.	<i>Vertebralina striata</i> d'Orb.	f.	r.
29.	<i>Hauerina compressa</i> d'Orb.	.....	v.r.
30.	<i>Peneroplis pertusus</i> (Forskål)	v.c.	v.c.
31.	" <i>arietinus</i> (Batsch)	.....	v.r.
32.	" ( <i>Monalysidium</i> ) <i>cylindraceus</i> (Lam.)	f.	.....
33.	" ( <i>M.</i> ) <i>sollasi</i> Chapman	f.	.....
34.	<i>Orbitolites marginalis</i> (Lam.)	v.c.	v.c.
35.	" <i>duplex</i> Carpenter	.....	v.r.
36.	<i>Alveolina melo</i> d'Orb.	.....	r.
37.	<i>Haddonina minor</i> Chapman	f.	.....
38.	<i>Textularia conica</i> d'Orb.	v.r.	.....
39.	" <i>gramen</i> d'Orb.	c.	f.
40.	" <i>siphonifera</i> Brady	r.	f.
41.	" <i>agglutinans</i> d'Orb.	.....	f.
42.	<i>Pavonina flabelliformis</i> d'Orb.	v.r.	f.
43.	<i>Gaudryina baccata</i> Schwager	.....	v.c.
44.	<i>Verneuilina spinulosa</i> Reuss	v.c.	f.
45.	<i>Vaginulina legumen</i> d'Orb.	.....	v.r.
46.	<i>Sagraina bifrons</i> Brady	v.r.	.....
47.	" <i>raphanus</i> Parker & Jones	.....	r.
48.	<i>Globigerina bulloides</i> , var. <i>triloba</i> Rss.	v.c.	c.
49.	" <i>helicina</i> d'Orb.	.....	v.r.
50.	" <i>aquilateralis</i> Brady	v.r.	.....
51.	" <i>dutertrei</i> d'Orb.	.....	v.r.
52.	<i>Spirillina inequalis</i> Brady	f.	.....
53.	" <i>tuberculo-limbata</i> Chapman	r.	r.
54.	" <i>limbata</i> Brady	.....	v.r.
55.	" <i>decorata</i> Brady	.....	v.r.
56.	<i>Cymbalopora poeyi</i> (d'Orb.)	v.c.	v.c.
57.	" <i>tabellæformis</i> Brady	v.r.	v.c.
58.	" ( <i>Tretomphalus</i> ) <i>bulloides</i> (d'Orb.)	c.	v.c.
59.	<i>Discorbina globularis</i> (d'Orb.)	r.	v.c.
60.	" <i>polystomelloides</i> P. & J.	.....	v.c.
61.	<i>Planorbulina larvata</i> P. & J.	.....	c.
62.	" <i>acervalis</i> Brady	.....	v.c.
63.	<i>Carpenteria balaniformis</i> Gray	v.r.	.....
64.	<i>Pulvinulina menardi</i> (d'Orb.)	r.	v.r.
65.	" <i>repanda</i> (F. & M.)	f.	.....
66.	" <i>lateralis</i> Terq.	c.	r.
67.	<i>Rotalia beccarii</i> (L.)	v.c.	f.
68.	<i>Gypsina globulus</i> (Reuss)	v.r.	v.r.
69.	" <i>inhærens</i> (Schultze)	f.	c.
70.	<i>Polytrema miniaceum</i> (Pallas)	v.r.	v.c.
71.	" " var. <i>alba</i> Carter	.....	v.c.
72.	<i>Polystomella crispa</i> (L.)	c.	f.
73.	" <i>macella</i> (F. & M.)	f.	v.r.
74.	" <i>subnodosa</i> Münster	.....	v.r.
75.	<i>Amphistegina lessoni</i> d'Orb.	v.c.	v.c.
76.	<i>Heterostegina depressa</i> d'Orb.	r.	v.c.

5. Contributions to the Ichthyology of the Congo.—I. On some new Fishes from the French Congo. By G. A. BOULENGER, F.R.S.

[Received March 1, 1902.]

(Plates XXII.—XXIV.<sup>1</sup>)

The British Museum has recently received from its excellent correspondent Mr. G. L. Bates a single fish obtained by him in the Ja River, flowing into the Sanga, an affluent of the right bank of the Congo, and this fish proves to belong to an undescribed species which requires the establishment of a new genus of Siluridæ.

At the same time the Director of the Royal Brussels Museum has entrusted me, at the request of my friend M. L. Dollo, with the study of the Congo Fishes preserved in that establishment. Among these I have found a small series of specimens coming from the Lukula River (sometimes spelt Likuala), another affluent of the right bank of the Congo, parallel to the Sanga. This series contains examples of five species:—*Marcusenius sphecodes* Sauvage, *Alestes kingsleyæ* Günther, *Auchenoglanis ballayi* Sauvage (all three previously known from the Ogowe only, and therefore new to the Congo system), and two new forms which are now described under the names of *Labeo lukulæ* and *Chilochromis duponti*.

ALLABENCHELYS, g. n.

Intermediate between *Clarias* and *Clariallabes*. Agreeing with the former in the free border to the eye, with the latter in the sides of the head being unprotected by bone.

ALLABENCHELYS LONGICAUDA, sp. n. (Plate XXII. figs. 1, 1 a.)

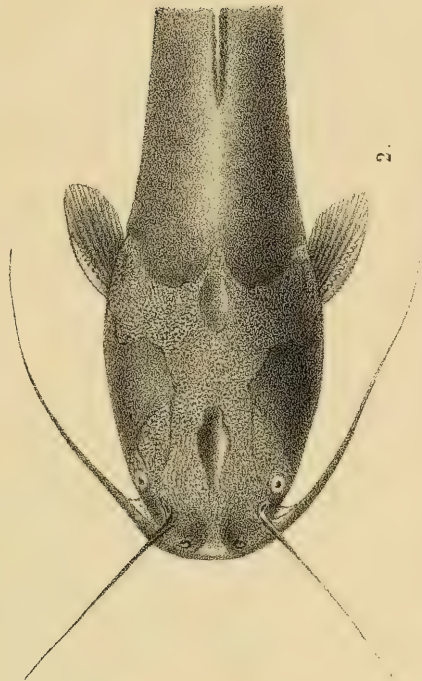
Depth of body 12 times in total length, length of head 6 times. Head  $1\frac{1}{4}$  as long as broad, smooth above, the bony casque, in the middle, only one third the width of the head; postorbital shield narrow; supraoccipital process acutely pointed; a small frontal fontanelle; eye very small, its diameter 4 times in length of snout and 6 times in interorbital width; latter not quite half length of head; band of præmaxillary teeth 5 times as long as broad; vomerine teeth conical, in a crescentic band, which, in the middle, is nearly as broad as the præmaxillary band. Nasal barbel nearly half as long as head; maxillary barbel as long as head, reaching middle of pectoral spine; outer mandibular barbel  $\frac{2}{3}$  length of head, inner  $\frac{1}{2}$ . Gill-rakers moderately long, 12 on anterior arch. Clavicles hidden under the skin. Dorsal fin with 80 rays, anal with 60, both narrowly separated from the caudal; the distance between the origin of the dorsal and the occipital

<sup>1</sup> For explanation of the Plates, see p. 237.





1a.

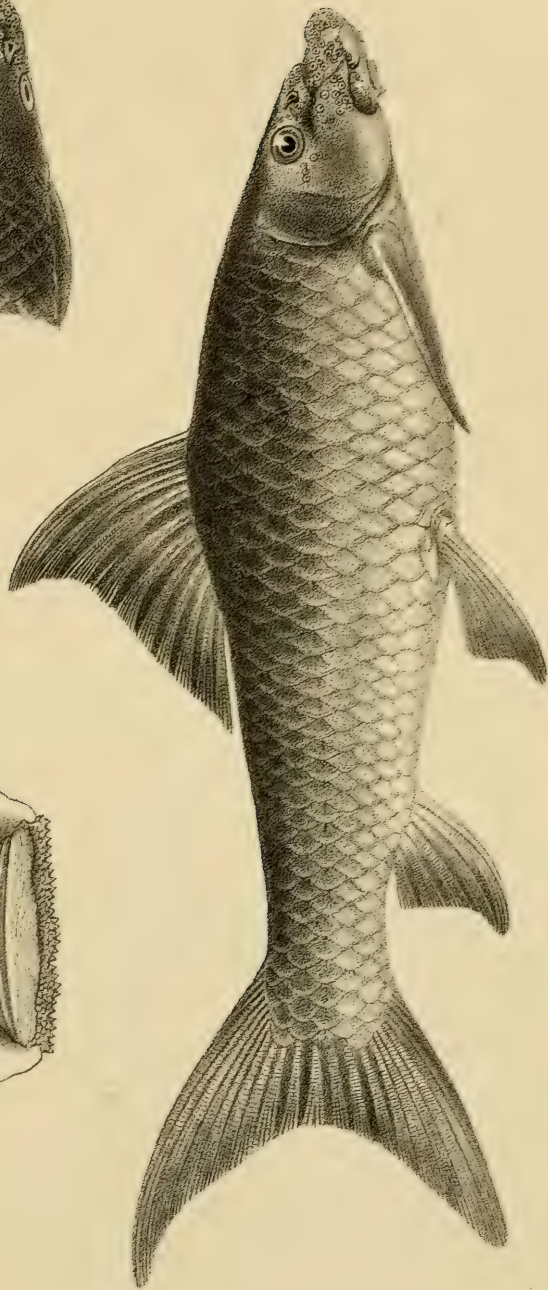
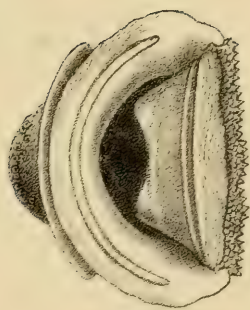
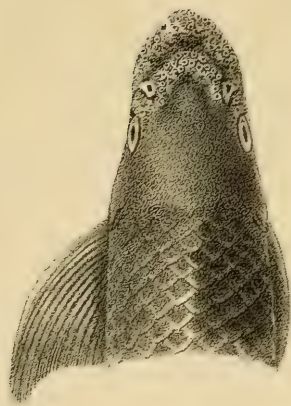


2.



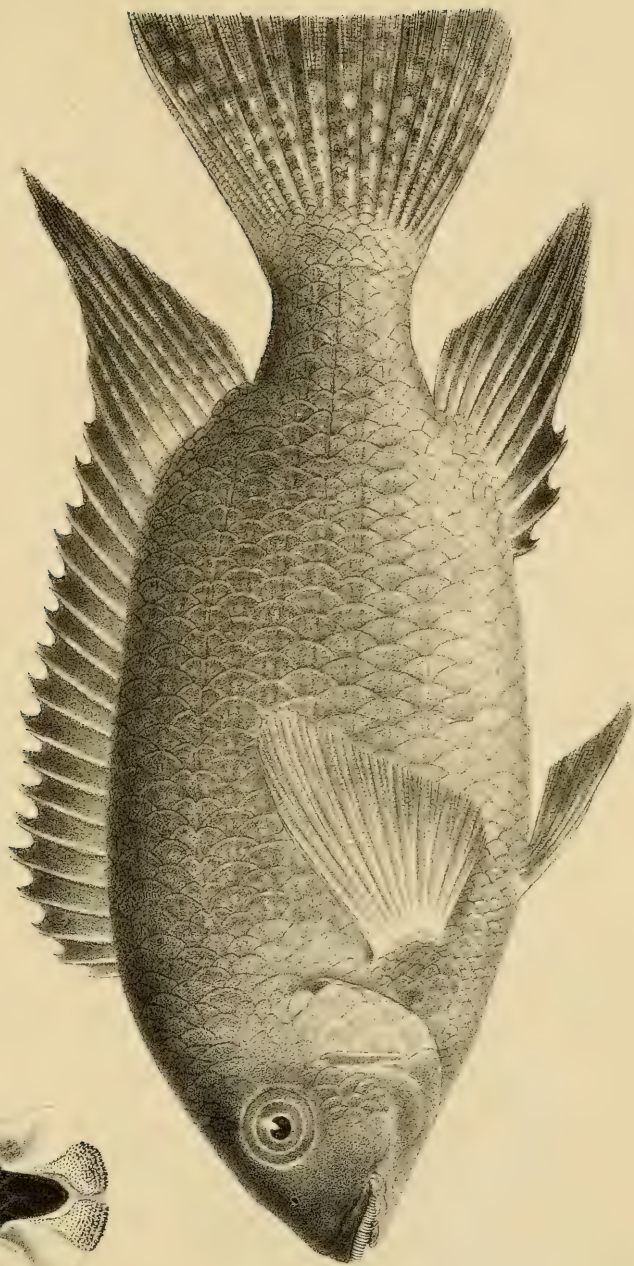
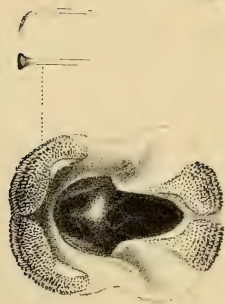
1.













process  $\frac{3}{5}$  the length of the head. Pectoral half the length of the head; spine smooth,  $\frac{3}{5}$  the length of the fin. Ventrals small, twice as distant from the root of the caudal as from the end of the snout. Caudal  $\frac{2}{3}$  the length of the head. Dark olive-brown above, whitish beneath; vertical fins dark, anal edged with white (red?).

Total length 210 millim.

A single specimen was obtained by Mr. G. L. Bates in the Ja River, French Congo, 250 miles from the coast.

The nearest ally of this new fish is *Clariallabes melas* Blgr., from the Lower Congo, which differs, apart from the generic character of the absence of a free border to the eye, in the longer head, the more numerous rays to the dorsal and anal fins, which unite with the base of the caudal, and the presence of serrations on both sides of the pectoral spine. *Clariallabes melas* has never been figured; the upper surface of the head and of the anterior part of the body is represented on Pl. XXII. fig. 2, for comparison with *Allabenchelys longicauda*.

#### LABEO LUKULÆ, sp. n. (Plate XXIII.)

Body compressed, its depth nearly 4 times in total length; length of head  $4\frac{1}{3}$  times in total length. Head once and a half as long as broad; snout obtusely pointed, strongly projecting beyond the mouth, covered with large nuptial tubercles; eye supero-lateral, in the second half of the head, its diameter 6 times in length of head,  $2\frac{2}{3}$  in width of interorbital region, which is flat; width of mouth, with folded lips, half length of head; rostral flap and anterior border of lip not denticulated; posterior border of lip denticulated; inner surface of lip with numerous feeble, transverse plicæ; a minute barbel,  $\frac{2}{5}$  the diameter of the eye, hidden in the folds at the sides of the mouth. Dorsal III 10, with notched upper border; the longest ray equals the length of the head and twice that of the last; fin a little nearer the root of the caudal than the end of the snout. Anal II 5; longest ray  $\frac{2}{3}$  length of head. Pectoral falcate, as long as head, not reaching base of ventral. Ventral reaching vent, its first ray falling under the seventh (fourth branched) ray of the dorsal. Caudal deeply forked, with pointed lobes. Caudal peduncle once and a half as long as deep. Scales  $35\frac{5\frac{1}{2}}{7\frac{1}{2}}$ ; 4 series of scales between the lateral line and the root of the ventral; 12 scales round the caudal peduncle. Dark olive, belly whitish.

Total length 250 millim.

A single specimen from the Lukula River, preserved in the Royal Natural History Museum, Brussels. This species is to be placed near *L. macrostomus*, *L. greenii*, and *L. nasus*, from all three of which it is easily distinguished by the number of scales round the caudal peduncle—12 instead of 16 or 18; in this character agreeing with *L. parvus*, which differs in the shorter, less prominent snout, the shorter caudal peduncle, and one series of

scales less both above and below the lateral line. The numbers of scales are as follows in the six Congo species with notched dorsal fin with 10 or 11 branched rays, supero-lateral eyes, and a single barbel on each side :—

*L. falcifer* Blgr.—Sq. 39  $\frac{7-8}{9-10}$ , 5 between L. l. and V., 20 round caud. ped.

*L. macrostomus* Blgr.—Sq. 38–39  $\frac{7}{7-8}$ , 4 between L. l. and V., 16–18 round caud. ped.

*L. greenii* Blgr.—Sq. 37–38  $\frac{6}{7}$ , 4 between L. l. and V., 16 round caud. ped.

*L. nasus* Blgr.—Sq. 38–39  $\frac{6}{7}$ , 4 between L. l. and V., 16 round caud. ped.

*L. lukulae* Blgr.—Sq. 35  $\frac{5}{7}$ , 4 between L. l. and V., 12 round caud. ped.

*L. parvus* Blgr.—Sq. 33–35  $\frac{4}{5-6}$ , 3 between L. l. and V., 12 round caud. ped.

#### CHILOCHROMIS, g. n.

Body moderately elongate; scales cycloid. Jaws with very broad bands of bristle-like movable teeth with club-shaped inbent crowns; rami of lower jaw approximated, spatulate in front, connected with the upper jaw by a broad, thin lip; maxillary concealed under the præorbital. Dorsal with 17 spines, anal with 3.

This remarkable new genus approaches *Petrochromis* Blgr., but differs from it in the narrower lower jaw and in the teeth being simply club-shaped, instead of bi- or tricuspid. I have much pleasure in naming the species in honour of the eminent Director of the Brussels Museum, one of the pioneers in the geological exploration of the Congo Basin.

#### CHILOCHROMIS DUPONTI, sp. n. (Plate XXIV.)

Depth of body  $2\frac{1}{2}$  times in total length, length of head  $3\frac{1}{2}$  times. Snout rounded, with arched profile, a little longer than the diameter of the eye, which is contained  $3\frac{1}{2}$  times in the length of the head and  $1\frac{1}{2}$  in the interorbital width; mouth extending to below the nostril; teeth very numerous, with reddish-brown crowns, those of the upper jaw in 8 or 9 transverse series, those of the lower jaw forming two spoon-shaped groups; the inner teeth smaller than the outer; 3 or 4 series of scales on the cheek; large scales on the opercle. Gill-rakers short and slender, 15 on lower part of anterior arch. Dorsal XVII 10; last spine longest,  $\frac{2}{5}$  length of head; middle soft rays longer than the head. Pectoral acutely pointed, as long as the head. Ventral not reaching the vent. Anal III 8; third spine longest, a little shorter than longest dorsal; middle soft rays  $\frac{3}{4}$  length of head. Caudal fin feebly emarginate. Caudal peduncle as long as deep. Scales  $33\frac{3\frac{1}{2}}{10}$ ; lat. l.  $\frac{22}{10}$ . Uniform olive-brown above, yellowish beneath; fins greyish.





J. Smit del. et lith.

Mintern Bros. imp.

CERCOPITHECUS OTOLEUCUS



Total length 220 millim.

A single specimen from the Lukula River, preserved in the Royal Natural History Museum, Brussels.

I avail myself of this opportunity to propose the name of *Pelmatochromis polyodon* for the fish from Monsembe which I have recently described (Ann. Mus. Congo, Zool. ii. p. 53) as *P. taniatus*, having overlooked the fact that the same name had been previously bestowed on a species from Nigeria.

#### EXPLANATION OF THE PLATES.

##### PLATE XXII.

- Fig. 1. *Allabenchelys longicauda*, p. 234,  $\frac{2}{3}$  nat. size.  
 1 a. " " Upper surface of head,  $\frac{2}{3}$  nat. size.  
 2. *Clariallabes melas*, p. 235,  $\frac{2}{3}$  nat. size.

##### PLATE XXIII.

*Labeo lukulae*, p. 235, with view of open mouth,  $\frac{2}{3}$  nat. size.

##### PLATE XXIV.

*Chilochromis duponti*, p. 236, with view of open mouth,  $\frac{2}{4}$  nat. size.

April 15, 1902.

Prof. G. B. HOWES, LL.D., F.R.S., Vice-President,  
 in the Chair.

The Secretary read the following report on the additions made to the Society's Menagerie in March 1902:—

The registered additions to the Society's Menagerie during the month of March were 146 in number. Of these 38 were acquired by presentation, 18 by purchase, 3 were born in the Gardens, and 87 were received on deposit. The total number of departures during the same period, by death and removals, was 143.

Amongst the additions attention may be specially directed to:—

1. A Monkey of the genus *Cercopithecus*, procured by Major Delmé-Radcliffe in the Latuka Mountains, about a hundred miles east of the Upper Nile in Northern Uganda, and presented to the Society on March 1st. This Monkey appears to belong to a new species allied to *Cercopithecus leucampyx*, but easily distinguishable by the white ear-tufts and grey back. I propose to name it Delmé-Radcliffe's Monkey (*Cercopithecus otoleucus*). It may shortly be described as follows:—

*CERCOPITHECUS OTOLEUCUS.* (Plate XXV.)

Above fuliginous, back more or less grizzled with pale fulvous, head above black; frontal line white, with hairs rather elongated;

ears blackish, with a conspicuous patch of white hairs in the lower part of the conch; sides of face grizzled like the back, but more greenish; nose blackish, chin whitish; limbs and tail black; belly and underparts pale whitish grey: whole length of body about 13 in.; tail 17 in.

*Hab.* Forests of Latuka Mountains, Northern Uganda.

*Obs.* Closely allied to *C. leucampyx* of West Africa, but distinguished by its white ear-patches, blacker head, greyer back, and much paler colour beneath.

[P.S. *July 1st.*—Herr Oscar Neumann, who has examined this Monkey, is of opinion that it is nearly allied to, if not identical with, *Cercopithecus stuhlmanni* of Matschie (Sitzsb. Ges. naturf. Fr. Berlin, 1893, p. 225). This is possibly the case, but the description does not quite agree with our specimen.]

2. A Panda (*Elurus fulgens*), from Northern India, obtained by purchase on March 4th. This scarce animal, which is the third specimen received by the Society, was in a weak state on arrival and unfortunately did not live long.

3. Another collection of ten Indian Birds, presented by Mr. E. W. Harper, F.Z.S., all belonging to species new to the Collection. Amongst them the Stork-billed Kingfisher (*Pelargopsis gurvial*) and the Mountain-Thrush (*Oreocincla dauma*) are particularly interesting.

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Prof. Bell, F.Z.S., exhibited two arms of an injured Starfish of the genus *Luidia*, from the west coast of Ireland, which had undergone repair at their free ends. These regenerated parts were unlike the rest of the arm, and had a striking though not exact resemblance to the free ends of the arms of an *Astropecten*.

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Dr. Forsyth Major, F.Z.S., exhibited some selected specimens from a collection of fossil bones recently received by the Natural History Museum from Cyprus, where they had been discovered in caves by Miss Dorothy M. A. Bate, who started last year for that island with the express purpose of discovering and exploring ossiferous caverns.

The remains proved to be those of a pigmy Hippopotamus, about half the size of a middle-sized *Hippopotamus amphibius*, and could not be distinguished from Cuvier's "*Petit Hippopotame fossile*" (*H. minutus* Blainv.), which was smaller than the so-called "*H. minutus*" of Malta and otherwise different. Cuvier's description had been based on scanty remains in the Paris Museum and from private collections in Bordeaux and Brussels, all of them without any record of their origin, but which had ultimately (Oss. Foss. 4th ed. ii. p. 490, 1834) been supposed to come from a place, never identified before nor after, between Dax and Tartas in the South of France. Dr. Forsyth Major now suggested that the fossils described by Cuvier were, in reality, from Cyprus also.



The fossils exhibited showed affinities, on the one hand, with the pigmy Hippopotamus of Western Africa, *Charopsis liberiensis*; on the other, with some remains from the Lower Pliocene of Casino (Italy). They were considered by the exhibitor as a further illustration of the assumption that many of the Pleistocene Mammals of the Mediterranean Islands were the little modified survivors of Tertiary forms from the adjoining continents, from which the islands had been severed during that period.

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The following papers were read :—

1. On the Windpipe and the Heart of the Condor. By FRANK E. BEDDARD, M.A., F.R.S., Vice-Secretary and Prosector of the Society.

[Received March 12, 1902.]

(Text-figures 29–32.)

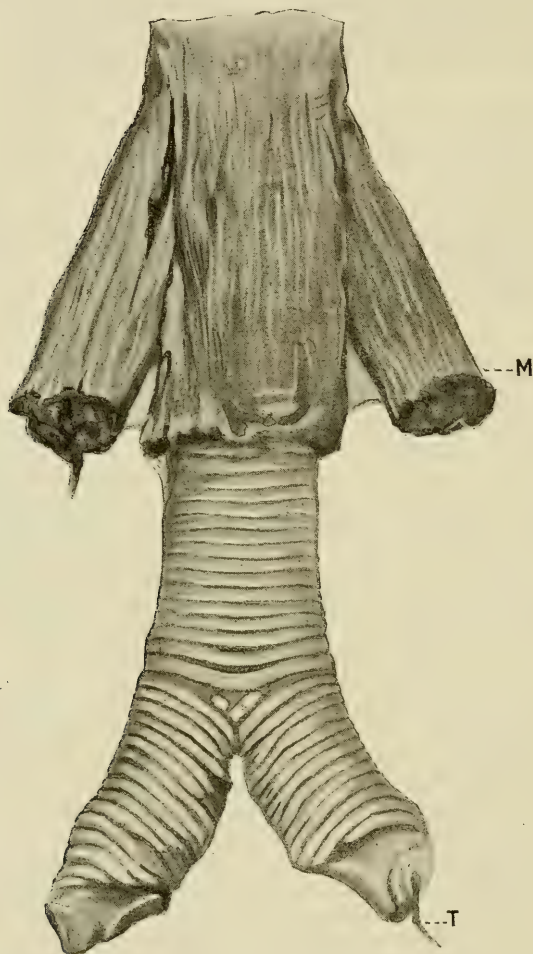
The generalities in the structure of the windpipe of the Condor are pretty well known, and have been so for long, though the information as given is not always exact. There has not been, however, so far as I am aware, a detailed comparison of that organ in the two sexes. As sexual differences in the windpipe are to be found at least in *Sarcorhamphus gryphus*, I have thought it worth while to draw up an account of the matter. In the female *Sarcorhamphus gryphus* the two bronchi end, as I described and figured them some years since<sup>1</sup>, in a membranous tract of some length; the cartilaginous rings of the bronchi in fact cease to exist some way before the bronchi plunge into the lung-substance. This membranous tract of each bronchus is enveloped and completely covered by a layer of muscle, which is prolonged into several strands of muscle tying the bronchus down to the membranous surface of the lung. The figure of the windpipe in the female Condor illustrating my account of it was drawn from the recently dead specimen, and is, I believe, quite accurate. I have examined also the windpipe of a female example of the second species of the genus *Sarcorhamphus*, viz. *S. equatorialis*, which I had preserved at the time of the death of this specimen. The end of each bronchus is, in precisely the same way as in *S. gryphus*, covered with a sheet of muscle. I do not give here a detailed account of the arrangement of the muscular tags proceeding from this sheath of muscle and tying down the bronchus to the lung-surface, since they appear to be, as far as I can judge, identical with the arrangements to be seen in *Sarcorhamphus gryphus*.

I have quite lately had the opportunity, through the death of one of these birds, of examining the windpipe in the male *Sarco-*

<sup>1</sup> "Notes on the Anatomy of the Condor," P. Z. S. 1890, p. 142.

*rhamphus gryphus*. I exhibit drawings of the windpipe (text-figs. 29, 30), which are quite accurate, and illustrate the various features to which I desire to direct attention. It will be seen

Text-fig. 29.



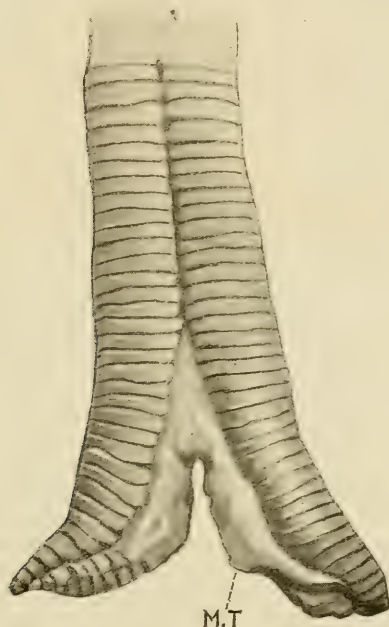
Lower end of windpipe of male *Sarcorhamphus gryphus*, front view.

M, extrinsic muscles; T, muscular tag at end of bronchus.

that each bronchus ends in the male bird, as it does in the female, in an entirely membranous section of considerable length in proportion to the entire bronchus. The proportions are rightly

shown in the drawings to which I have called attention. Here, however, the resemblance ends. For in the male bird I can find no trace visible to the naked eye of the muscular sheath which covers this part of the bronchus in the hen bird. I have carefully looked for these muscles both in the fresh windpipe and after it had been preserved in alcohol. There is no doubt in my mind that the difference indicated does really exist. Moreover, the rather abundant slips of muscle, which, in the hen bird, tie down the end of the bronchus to the membranous surface of the

Text-fig. 30.



Lower end of windpipe of male *Sarcorhamphus gryphus*, back view.

M.T, membrana tympaniformis.

lung, are only just recognizable in the cock bird. I found but one tiny slip (T in text-fig. 29) representing this very striking feature of the windpipe of the female. This required careful looking for; there is nothing to strike the eye forcibly.

It appears, therefore, that in *Sarcorhamphus gryphus* certainly, and in *Sarcorhamphus equatorialis* probably, there is a marked difference between the sexes in the conformation of the syrinx; and that, in the second place, the more complicated organ is that of the female, and not of the male sex. These birds have no

proper voice, but only "hiss like a reptile." Whether the musculature of the lower part of the bronchi in the females produces any difference in the sounds uttered, I am not aware.

This is the principal fact in the structure of the windpipe of *Sarcorhamphus* to which I have desired to call attention. There is, however, another matter to which I did not give any attention in my description of the windpipe of the female Condor. Prof. Fürbringer has remarked that "Die . . . Cathartidæ heben sich durch vollkommene bronchiale Ringe besonders hervor."<sup>1</sup> I have briefly referred to the fact<sup>2</sup> that in the members of this group there is, at least sometimes, an imperfectly formed tracheo-bronchial syrinx—imperfect in the fact that there is no great modification of the rings at the bifurcation, but suggesting a tracheo-bronchial syrinx in the incompleteness of the bronchial rings, which are indeed semi-rings. In *Sarcorhamphus gryphus* this incompleteness of the bronchial rings is very plain, as the drawing submitted herewith (text-fig. 30, p. 241) shows. Moreover, the membranous space lying between the approximated ends of the bronchial semi-rings on the dorsal aspect of the windpipe is prolonged upwards for a considerable distance along the trachea, gradually diminishing until the tracheal rings, at first incomplete, become fully complete rings passing without a break right round the windpipe. There is even—at least I so interpret it—a slight suggestion of a pessulus; this is in the shape of a small piece of cartilage, again divided into two, which lies at the point of bifurcation of the trachea into the two bronchi.

I have had an opportunity of comparing the windpipe of the Condor with that of the American Vulture, its near ally, *Cathartes atratus*, of which several specimens have recently died in the Society's Gardens. These examples were of both sexes, and I have not been able to note any sexual difference such as characterizes the Condor. In *Cathartes*, moreover, the bronchus, although it does end in a short membranous tract, is not invested with muscle as in the female *Sarcorhamphus*. In fact, the appearance of the bronchi at their termination in the lung is much like that of the male *Sarcorhamphus*. Furthermore, in each case that I examined, three muscles attached at one end to the ribs were inserted on to the surface of the lung in the vicinity of the entrance of each bronchus. It seems to be reasonable to compare these muscles, which are of course the usual lung-muscles ("diaphragm" of some authors), to those found in most birds arising from the ribs and implanted upon the membrane covering the lungs. But in addition to this comparison, it seems also possible to compare them especially with the "tags" of muscle already described in the Condor as connected with—or, indeed, arising from—the sheet of muscle covering the membranous termination of the bronchus. In *Cathartes*, however, all trace of an attachment to the bronchus itself was lost; the muscles are

<sup>1</sup> Untersuchungen z. Morph. u. Syst. d. Vögel, Amsterdam, 1888, p. 1086.

<sup>2</sup> The Structure and Classification of Birds, London, 1898, p. 482.



plainly, as in other birds, inserted on to the surface of the membrane covering the lung. Nevertheless, it appears to me that possibly the conditions obtaining in these two kinds of birds may give a clue to the origin of a portion of this musculature of the lung. I have suggested already, in my former paper upon the Condor, that the sheet of muscle enwrapping the end of the bronchus may be the remnant of an intrinsic syringeal muscle altered in function in correspondence with the degeneration of the syrinx itself. A second stage is seen in the male *Sarcorhamphus*, where the muscle is reduced to the one or two "tags" which tie down the end of the bronchus to the lung-surface. The final stage is shown in *Cathartes*, in which birds in both sexes the "tags" of muscle are present and well developed, but have entirely lost all special relation to the end of the bronchus. This, however, is at present a suggestion for the origin of those muscles, the nature and distribution of which require, and have not yet had, detailed attention in many groups of birds.

The heart of the Condor has been dealt with by Gegenbaur<sup>1</sup> and by myself<sup>2</sup>. We have both recorded the occurrence of traces of the septal flap of the right auriculo-ventricular valve, which is for the most part missing in Birds. I therefore examined with particular interest the heart of the male *Sarcorhamphus gryphus*, to the windpipe of which I have directed attention above. Gegenbaur found in a heart examined by himself "a fold . . . which is formed by a thickening of the endocardium"; this fold was found to run backwards "from the anterior origin of the muscular valve." It is not altogether easy to follow the description given by Gegenbaur, since it is unaccompanied with any drawings. I take it, however, that what Gegenbaur saw in the heart studied by him was a prolongation of that part of the valve, arising to the left of the great papillary muscle, tying the valve to the free non-septal wall of the ventricle: to the left, that is to say, when the right ventricle is opened and looked at from in front. Now I have already brought forward reasons for considering that this part of the valve, which appears occasionally to be rather membranous in constitution and is always of thinner texture than the larger half of the valve, is the equivalent of the septal half of the valve in the Crocodile's heart<sup>3</sup>. A further study of the Crocodile's heart led Dr. Chalmers Mitchell and myself to the same conclusion. What Prof. Gegenbaur therefore has been able to place on record is a still greater extension of this septal half of the right auriculo-ventricular valve. In a vanishing structure such fluctuations are generally met with.

In the corresponding valve of the Monotreme heart, Prof. Lankester found considerable variations in the amount of the septal half of the valve which was present; and I do not doubt that careful measurements would prove the same thing for the

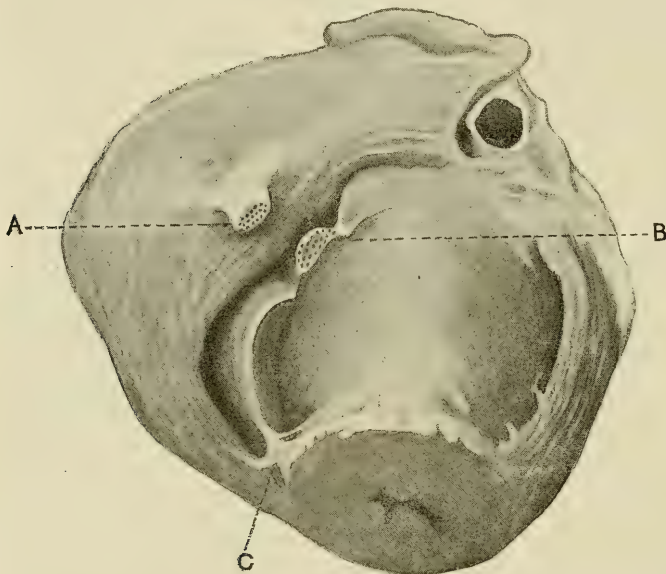
<sup>1</sup> "Zur vergleichenden Anatomie des Herzens," Jen. Zeitschr. ii. 1866, p. 365.

<sup>2</sup> P. Z. S. 1890, p. 144.

<sup>3</sup> "On the Structure of the Heart of the Alligator," P. Z. S. 1895, p. 348.

rudimentary septal flap of other birds. The traces of the septal flap, other than this definite piece of that flap noted by myself in the Condor's heart, consisted in "a series of tiny yellowish spots and vesicles a little way from the posterior margin of the atrio-ventricular orifice, which formed a line occupying a position identical with that which would be occupied by a septal part of the valve if it were present." These structures, possibly pathological, seemed to me and still seem, to be possibly a reminiscence of that half of the valve. Apart, however, from this pathological and thus more questionable state of affairs, we have Gegenbaur's positive assertions. In the heart which I have most recently

Text-fig. 31.



Heart of *Sarcorhamphus gryphus* opened so as to display the interior of the right ventricle.

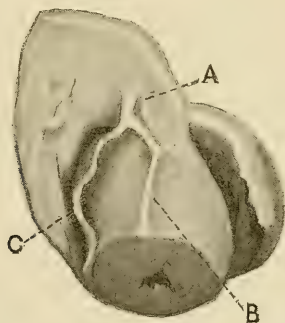
A, cut end of papillary muscle tying valve to septal wall of heart ;  
B, opposite end of the same ; C, rudiment of septal flap.

examined there were no traces, that I could discover, of an extension of the top half of the septal flap ; but, on the other hand, as is shown in the drawing submitted herewith (text-fig. 31), a considerable piece of muscular tissue extended from the lower end of the invariably present portion of the valve in the direction of the rudimentary slip at its other end. A line joining the letters A and B in the drawing would make a complete septal half to this valve. It cannot, I think, be doubted that this structure is a rudiment of the chiefly missing septal half of the valve ; and if

the two hearts, this one and the heart described by Prof. Gegenbaur, were to be reproduced in a composite drawing, we should in all probability see a bird's heart with a right auriculo-ventricular valve as complete as is that of the Crocodile. It may be noted, moreover, that in the Crocodile's heart (see the figures illustrating the paper by myself and that by Dr. Mitchell and myself) the portion of the septal half of the valve which is nearest to the half of the valve attached to the free wall of the right ventricle is entirely muscular, the fibrous portion of the valve lying more to the right. The comparison therefore becomes so far more exact. A still further reduction of this already reduced representative of the lower half of the septal flap of the valve might result in such small muscular pillars, arising from the ventricular septum and connecting together the two walls of the ventricle such as occur in various birds, and which I have especially called attention to in the heart of *Chunga* in my paper already quoted.

In addition to the heart of the Condor, I have had recently the opportunity of examining the heart of another bird which shows

Text-fig. 32.



Heart of *Scythrops novæ-hollandiæ* cut open so as to display interior of right ventricle.

A, papillary muscle ; B, tendinous seam extending from the same ; C, valve.

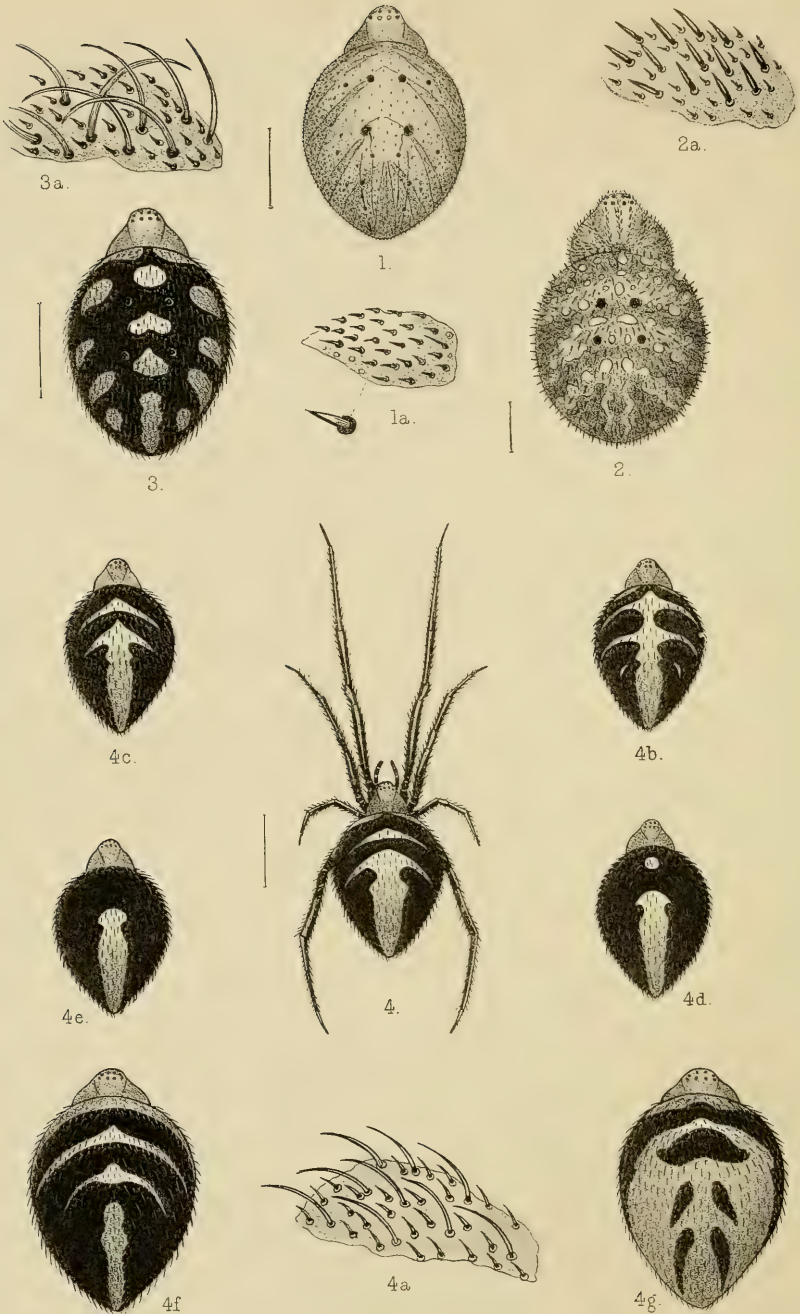
some persistent traces, as I regard certain structures to be described immediately, of the missing half of the right auriculo-ventricular valve. The accompanying sketch (text-fig. 32) is a drawing of the heart of a Cuckoo (*Scythrops novæ-hollandiæ*), from which, as in the case of the Condor's heart just described, the apex has been removed. The right ventricle is cut and reflected, and the complete half of the valve shown without further cutting. From the left half of the valve, which is attached to the interventricular wall, a white seam runs down the ventricular wall in the same direction as the piece of valve from which it originates. Unfortunately, as will be seen from an inspection of the sketch, the removal of the apex of the heart has destroyed the actual ending of the seam. It could not end, however, very

far from the end of the complete half of the valve. The seam, as I call it, has hardly a muscular or tendinous appearance. It is not perceptibly raised above the muscle which forms the wall of the heart; it is only conspicuous through its decided white colour. This description, I should observe, applies to the heart after preservation in spirit. I received the whole bird from Australia in spirit some years since. But the seam is so marked, that I cannot but think that it would have been as obvious in the fresh heart as it is in that preserved in spirit. The appearance of the seam, in fact, suggests a thickening of the lining-membrane of the heart, the endocardium. It just runs on to the commencement of the left-hand piece of the muscular existing valve. Now it appears to me to be fair to construe this structure as a remnant of the otherwise chiefly missing septal flap of the atrio-ventricular valve. It may be admitted that its course is straighter than such a flap had when fully developed. But with rudimentary structures, alterations of one kind or another not related to their former functions are not uncommon. I do not, in fact, think that the length of the seam is against my interpretation of its nature. As to the possibility that it is a thickening of the endocardium, it seems to me that it is then very comparable to the "fold" described by Gegenbaur, "which is formed by a thickening of the endocardium." And Gegenbaur adds to the description that the fold in question arises "from the anterior origin of the muscular valve on the septum ventriculorum," which is precisely the origin that the seam described here by myself has. Gegenbaur's fold, however, runs "obliquely backwards and downwards," so that its position as a rudiment is more in accord with that interpretation. A final point is of some little interest. It is or has been believed that ontogenetically as well as phylogenetically the muscular or tendinous valves of higher vertebrates are first formed as simple thickenings of the endocardium, later invaded by muscle which itself later on is converted into tendon (as in higher mammals). The return, so to speak, of this rudiment of the septal half of the valve to its very earliest condition is worth emphasizing.

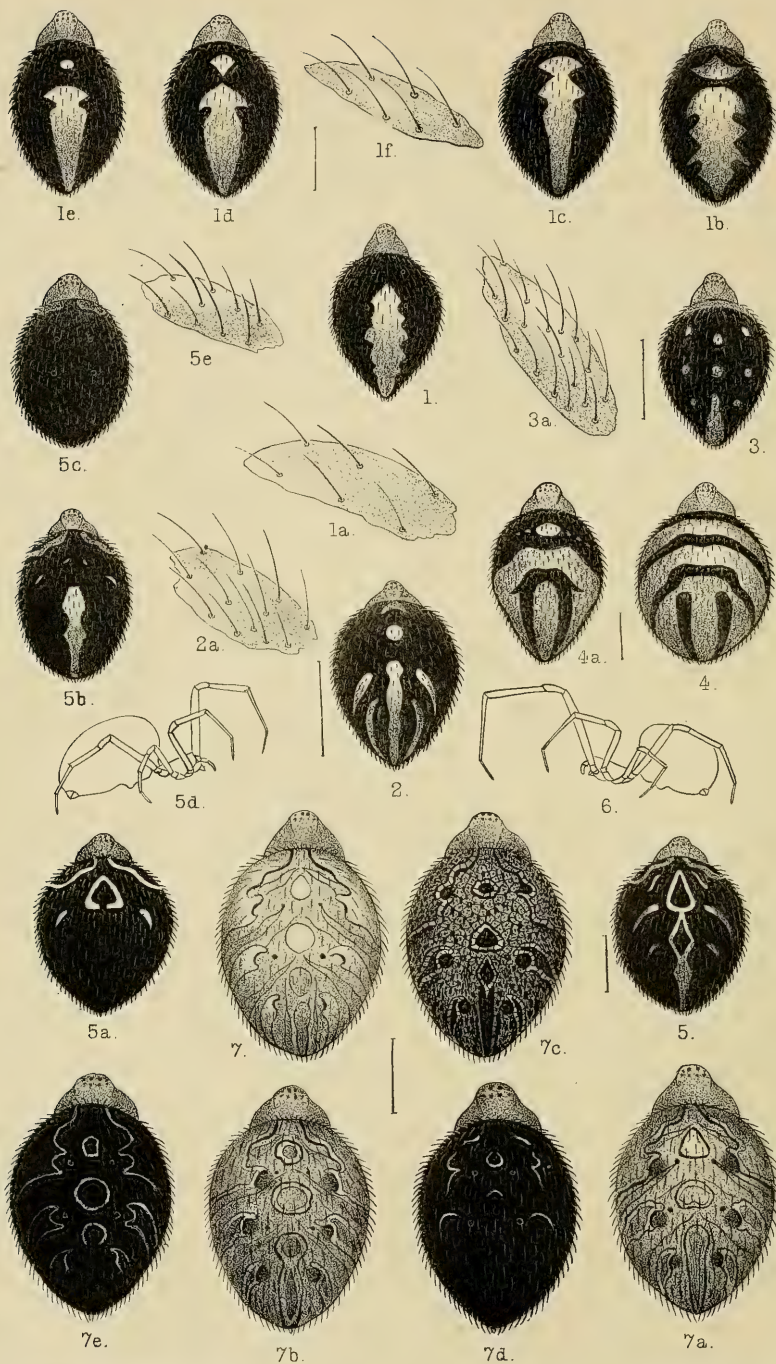
The facts that have just been dealt with raise another interesting question. At one time the descent of Birds from some Dinosaurian form was widely believed in; later this view lost some ground, until quite recently Prof. Osborn has recommended its serious reconsideration mainly on the grounds of the discovery of a fourth toe bent backwards, which has been shown to exist in the Dinosauria. This and some other features have added not a little to the bird-like characteristics of that group of Reptiles. On the other hand, there have not been wanting those who would assign the origin of Birds to a lower type of Reptile. The nature of the heart-valves seems to me to throw some light upon the question. At first sight, the arrangement of the auriculo-ventricular valves in the bird is more suggestive of the same valves in the tortoise than in the crocodile, the latter repre-











F. Pickard-Cambridge del. et lith.

West, Newman imp.

SPIDERS OF THE GENUS LATRODECTUS.



senting the type of an highly-organized reptile, and nearer to the Dinosaurs than any other living type. As in the genus *Testudo*, the right auriculo-ventricular valve of the Birds is almost always a clearly-defined and semi-lunar muscular flap, practically guarding only one side of the auriculo-ventricular orifice. In *Testudo*, as in the bird, the opposite side of the ventricle has a perfectly smooth surface, without even the rudiment of a ridge to correspond to the valve which lies on the left side of the auriculo-ventricular orifice. On the other hand, the left auriculo-ventricular aperture is guarded by a completely, or nearly completely, encircling valve in both tortoise and bird. Hardly any change is required to convert the right auriculo-ventricular valve of the tortoise into that of the bird. If no rudiments, such as those described in the present communication, of a septal half to the right auriculo-ventricular valve had been discovered, it might be reasonable to dwell upon the striking but really superficial likeness which this valve in the vast majority of existing birds shows to the corresponding valve in the tortoise. But it seems now to be clear that the simple valve in the bird's right ventricle is not the persistent and simple valve of the tortoise or some lower reptilian type; but that it has been derived from the reduction of a more complicated valve such as is possessed by the Crocodiles, and was very possibly possessed by the Dinosaurs. The evidence is therefore so far in favour of assigning to the birds an origin from some highly-developed reptilian type.

## 2. On the Spiders of the Genus *Latrodectus*, Walckenaer.

By FREDERICK PICKARD CAMBRIDGE, F.Z.S.

[Received February 25, 1902.]

(Plates XXVI. & XXVII.<sup>1</sup>)

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- II. List of Species and Sub-species recognized in this paper, p. 252.
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- IV. Explanation of the Plates, p. 261.

### I. INTRODUCTION.

The genus *Latrodectus* of Walckenaer (Tableau, p. 81, 1805), of which the type is *L. 4-tredecim-guttatus* (Rossi), 1790, comprises those very interesting Spiders which, under various local names, have been notorious in all ages and in all regions of the World where they occur on account of the reputed deadly nature of their bite.

As to the evidence, there can be no doubt whatever that the inhabitants of those regions suffer frequently from blood-poisoning

<sup>1</sup> For explanation of the Plates, see p. 261.

of a very serious nature, and that wherever the variety of *Latrodectus* occurs which is of black coloration with vivid red spots, particularly at the apex (or tail-end) of the abdomen, the blood-poisoning is ascribed to the "sting" of this spider. Of course the spider has no *sting* at the tail-end, but people who feel a sudden wound are not likely to note very carefully which end of the enemy is responsible for the damage. The tail-end being brilliant red, however, looks full of venom, and hence they have jumped to the conclusion that the sting lays there. To such an extent has this belief prevailed that in Guatemala, Mr. Sarg relates, the natives assert that the spider actually squirts out its venom at the victim, and if the fluid even touches the skin, an angry eruption will supervene. The fluid which is thus ejected is not venom, however, but merely liquid-silk, an adhesive treacly fluid which the spider squirts at a captive in order to impede its struggles for liberty. In many species of the family, Theridiidæ, to which *Latrodectus* belongs, the same phenomenon can be observed.

One may be pardoned for suspecting that the red colour has given rise to the supposition that the "sting" of these spiders is extremely venomous; and whether they are the true culprits or not, suspicion would naturally fall upon them at once amongst the ignorant and unobservant.

I have not heard that any venomous tendencies have ever been ascribed to *L. geometricus*, a large grey species, abundant in houses, outbuildings, and offices, where, if members of the genus are as bloodthirsty as has been alleged, adults and children are sure to have been bitten or "stung." I never once heard any of the natives accuse this species of stinging, or utter warnings as to the poisonous nature of its bite, though it was numerous in the houses throughout the Lower Amazons, and they were not behindhand in making the most of the dangers of the forest and the deadly nature of its inhabitants. But, then, there are no red spots on this species.

Of course it may also be argued that only those species with red spots are *poisonous*, and that the red colour is one of nature's danger signals; considerations which bring us no further towards a settlement of the question.

Mr. Crotch, writing in 1865, referring to the variety of the common European form found in Hierro, one of the Canary Islands, says that his entomological enthusiasm was checked by solemn warnings as to the dangers incurred from the bite of a certain large black lethiferous *Latrodectus malmignatus* var., generally causing death unless relieved by timely and internal doses of human excrement. A little later he remarks that, so great was the contempt induced by familiarity, that he could not be restrained from picking up the deadly monster, which, though tormented in the way presumed to be most provoking to a spider, persisted in lying inert in his hands, nor could it be induced to bite by any means.

The late Dr. Marx, too, tried many experiments on various animals by injecting the contents of the poison-sac of these spiders, but without any prejudicial results.

Numberless instances, however, have been quoted by authors of cases in which human beings, supposed to have been bitten by members of this genus, have manifested very serious symptoms. And this is especially the case in connection with the *Katipo*, the New Zealand variety. Mr. Urquhart says that his friend Mr. Robson stated that a man engaged in erecting a lighthouse was bitten on the neck, and went quite mad for some time. Mr. Wright, in 1869, gave many cases: an English boy was bitten as he sat amongst the grass inhabited by a *Katipo*; in another case the spider crawled up a boy's trousers and gave him a most dangerous wound. Carl Lumholtz, in his book 'Amongst Cannibals,' says that *Latrodectus hasseltii*, the Australian form, is very common and very dangerous to man; a friend of his, bitten in the leg, was seized with paralysis for three days. On the third day he had a cold perspiration, and recovered.

There are said to be two kinds of *Katipo*—one black without spots, the other black with red spots; and the latter is regarded as far the most poisonous.

One might quote instances of these distressing symptoms from all parts of the globe—North America, Chili, Central America, Australia, Madagascar, New Zealand, and the Mediterranean; and I must refer readers to the cases mentioned in the 'Bulletin' of the U.S. Department of Agriculture, for Jan. 1889 and onwards (see the list of Literature), for some startling cases of blood-poisoning, possibly caused by spider-bites, though there is no evidence that the bites were inflicted by *Latrodectus*.

But for well-authenticated cases of men, women, children, and animals manifesting the symptoms of blood-poisoning, cases which have been watched for days by medical men who may be presumed to have been competent observers, we must refer to the encyclopædic work of Dr. Puga Borne, published in 1891, -2, -3. Here we have stated the age, sex, condition and temperament of the sufferers, the time of the year, and the condition of the weather at the time the patient was bitten. Then we have minute diagnoses of the symptoms, followed by a careful consideration of the various remedies and their effect.

But both in the works referred to before and in the present case, there is always a noteworthy and important omission. No mention is made as to what evidence there was that the bite was actually inflicted by the spiders accused. Dr. Puga Borne states that a sheep was bitten by five of these spiders, but he does not say how they were encouraged to bite, how they were held, or what part of the sheep was bitten. One cannot believe that so many cases could be quoted by a medical man without he had actually witnessed the act of biting, but it is an extraordinary thing that he should not have thought it worth while to tell us how the experiments were carried out and how so venomous a

creature was held when being applied to the patient! The mandibles of *Latrodectus* are so insignificant that they would, for instance, scarcely pierce the thick skin of the fingers.

In the face of so much evidence, however, one would not wish to suggest that the animals whose symptoms are described were *not* actually bitten by the spider in the presence of and under the eye of a competent observer; only one must insist that it is a great pity that, if so, this is not distinctly stated and the *modus operandi* described by Dr. Puga Borne. It is so easy to settle the point once for all, and so silence scepticism. In every case, however, which has come under my notice, it has always been taken for granted at the outset that the wound was inflicted by the spider; and this being the only point on which proof is desirable, we are given abundant evidence on the character of the subsequent symptoms and every other point except this.

A New Zealand friend of mine assured me that his friend's dog had been bitten by a *Katipo*, and fancied he had proved the case up to the hilt when he declared that he had seen the dog running round in circles on the lawn. Certainly, there must have been something seriously wrong with his friend's dog, but the lamentable symptoms described were no proof that a *Katipo* was the cause of the trouble.

One would therefore urge those who happen to be in the *Katipo* country to try and get first-hand evidence. It is not sufficient to see a *Katipo* in the neighbourhood of the tragedy, nor to see one crawling on the victim's clothes, nor even to find one crawling under the clothes of the person bitten. If a dozen healthy boys could be induced for a consideration to allow themselves to be bitten under competent observation, the matter might be settled once and for all—or, failing this, experiments might be made on mice, though one cannot suggest how the spiders are to be induced to bite in either case.

These reports of the symptoms manifested in cases coming in for treatment suffering from the supposed bite of the spider are of no value whatever as evidence as to what was the originating cause of those symptoms.

It may be interesting to gather together the various names under which the members of this genus are known in the different countries where they enjoy such evil reputation.

In New Zealand it is known as the *Katipo*; in the Philippines as the *Lawalawa*; in Mexico and Central America as the *Araña capulina*, because of the resemblance which the abdomen bears to the fruit of the Capollin cherry (*Cerasus capollinus*); in Guatemala as the *Casampulga*; in Madagascar as the *Menavoudi*; in Chili as the *Pallu* or *Guina*; in Italy as the *Malmignatte*; in the Russian Steppes as the *Karakurt*; in Bolivia as the *Mico*; in Peru as the *Lucacha*; and in the Antilles as the *Araña naranja*.

I must here express my thanks to M. E. Simon, Prof. Kulczynski, Mr. H. R. Hogg, and Mr. R. I. Pocock for kindly allowing me to examine specimens of the genus; and I am also indebted



to Mr. R. Jenery-Shee, an expert in European languages, for kindly looking through Dr. Puga Borne's voluminous work in Spanish, in case I should have missed the paragraph which might have contained the evidence I required.

Of the forty-three described species referred to this genus, I am able to recognize six only as distinct, and perhaps eight as sub-species. Of the former, *L. hystrix*, *geometricus*, *pallidus*, *tredecimguttatus*, and *mactans* are probably good species. As to the others, it is very difficult at present to take up any decided position with regard to them, as must always be the case where we have under consideration forms which are actually, at the time of observation, undergoing those processes of differentiation, under the influence of individual variability combined with that of physical surroundings, which, in these early stages, have not yet brought about any definite structural difference, or even any variation in the more superficial characters of colour-pattern, which can be considered in any way constant and exclusive.

In the subjoined table will be found the characters by which the most distinct of the species and sub-species of the female sex can best be recognized. The males are not sufficiently well known to enable one to tabulate their characters.

#### Females.

- |  |  |
|--|--|
| A. Integuments clothed with small acanthoid spines and short stiff black spines .....  | <i>hystrix</i> Simon.  |
| B. Integuments clothed with fine short acanthoid spines and longer bristles, or with fine hairs only.  |  |
| I. Central anterior eyes distinctly larger than the laterals .....   | <i>geometricus</i> C. L. Koch.                                 |
| II. Central anterior eyes not larger than the laterals.  |  |
| 1. Integuments almost glabrous. Latero-ventral area clothed with acanthoid spines only. Abdomen entirely creamy-white, with the black impressed muscular scars very conspicuous, and sides slashed with brownish yellow .....  | <i>pallidus</i> O. P. Cambridge.                               |
| a. Eyes of anterior row, as a rule, equidistant <sup>1</sup> .   |  |
| a <sup>1</sup> . Size much larger, length from 12-14 mm. Abdomen either entirely black or brown, without any red spots or with a single square or elongate-oval red spot above the anal tubercle; or with a narrow central dorsal red stripe, broken into two round spots anteriorly, and with, or without, two oblique lateral red stripes. Ventral spot dumbbell-shaped, without a decided dark spot in the middle ..... | <i>mactans</i> Fabricius.                                      |
| b <sup>1</sup> . Size much smaller, length 7 millim. Abdomen rich brown, with three irregular transverse crimson cinctures (very variable in exact form however) and a central posterior crimson band. Ventral spot oblong-oval, with a decided dark spot or blotch in the middle .....  | { <i>curaçaviensis</i> Müller.<br><i>geographicus</i> Hasselt. |

<sup>1</sup> Characters drawn from the eye-formula are not reliable; they vary very much, even amongst examples from the same district.

- b. Eyes of anterior row not equidistant, centrals nearer together than to the laterals<sup>1</sup>.

[Note.—The following three species are, so far as I am able to judge from the material at hand, all of one fundamental form, namely, *tredecim-guttatus* Fabr., but they fall into certain groups more or less limited by locality. Subjoined are the characters of extreme examples.]

- a<sup>2</sup>. Legs of first pair longer in proportion ; tibia i. at least one-fourth longer than the carapace.
1. Abdomen either entirely black or brown, or with a central red band more or less broken up into distinct spots and three or more oval-elongate lateral spots. Ventral spot either absent or represented by a transverse band immediately below the genital rima, and often one above the spinners; probably also confluent, forming a larger spot ..... *tredecim-guttatus* Rossi.
  2. Abdomen black, with an oblong-oval, central, posterior apical red spot, with three very small white spots on each side. Ventral spot usually represented by a transverse bar below the genital rima ..... *menavodi* Vinson.
  3. Abdomen black, with a single central longitudinal red band, anteriorly either constricted or broken off to form a separate spot. Ventral spot either absent or with one or two transverse spots, or with a large dumbbell-shaped blotch ..... *hasseltii* Thorell.
- b<sup>2</sup>. Legs of first pair shorter in proportion ; tibia i. not longer than the carapace. Spider usually smaller ..... *katipo* Powell.

## II. LIST OF SPECIES AND SUB-SPECIES RECOGNIZED IN THIS PAPER.

(For references and dates of synonyms, see Alphabetical List.)

1. *LATRODECTUS HYSTRIX* E. Simon, 1889. (Plate XXVI. fig. 2.)  
(Species.)

This form is quite distinct from any others that have been taken in any part of the world, being clothed with short, stiff, stout black spines, and cannot be mistaken for anything else. Posterior row of eyes straight, approximately equidistant ; centrals one diameter from each other, slightly further from the laterals. Posterior centrals much larger than the anterior centrals. Central anteriors less than one diameter apart, one diameter from the laterals, and distinctly smaller. Laterals half a diameter apart.

The example figured was kindly lent by M. E. Simon, and another example was found by Col. Yerbury at Aden.

*Hab.* Aden (*Simon and Yerbury*).

2. *LATRODECTUS GEOMETRICUS* C. L. Koch, 1841. (Plate XXVII. fig. 7.)  
(Species.)

Synonym. *L. zickzack* (Karsch), sub *Theridium*.

This form is more distinct from the others than any except

<sup>1</sup> See note on p. 251.

*L. hystric.* See figures of the abdominal pattern. The central anterior eyes are always, in all the examples which have come before me, slightly larger than the laterals; and, though I am unable to find any real difference in the form of the palpal organs of the male, yet the vulva of the female is distinctly different from that of *L. mactans*. The egg-cocoon is also characteristic, being covered with small silky cusps, unlike that of *L. mactans*, which is of smooth silk.

This species I found commonly in the angles of windows in the towns and villages throughout the Lower Amazons. Specimens exhibit every variety of coloration from grey to black.

*Hab.* SOUTH AMERICA: San Pedro and Rio Apia, Paraguay, San Domingo and Curaçao (*Simon*); Brazil (*Keyserling*); Rio Janeiro (*Göldi*); Minas Geraes (*Rogers*); Lower Amazons, Santarem, etc. (*F. P. Cambridge*). AFRICA: Khartoum (*Voission*); Abyssinia, Mozambique, and Madagascar (*Simon*); Cape Colony, Table Mountain (*Hull*); Jansenville (*Miss Leppan*); Cape Verde Islands (*F. P. Cambridge*). INDIA: Kurrachee and Manora (*Townsend*). AUSTRALIA: Melbourne (*Hogg*).

3. LATRODECTUS PALLIDUS O. P. Cambridge, 1872. (Plate XXVI. fig. 1.) (Species.)

*Hab.* Plains of Jordan (*O. P. Cambridge*). Persian Gulf, Bushire (*Kurrachee Museum*).

4. LATRODECTUS MACTANS (Fabr.), 1775. (Plate XXVII. fig. 2.) (Species.)

Synonyms. Abbot's Drawings: 191, 194, 195, 395, 344.—

*L. formidabilis* Walck.—*L. variolus* Walck.—*L. intersector* Walck.—*L. formidabilis* Nicolet.—*L. variegatus* Nicolet.—*L. thoracicus* Nicolet.—*L. zorilla* (Walck.), sub *Tetragnatha*.—*L. dotatus* C. L. Koch.—*L. verecundum* (Hentz).—*L. lineatum* (Hentz).—*L. apicalis* Butler.—*L. carolinus* Butler.—*L. malmignathus*, var. *tropica* Van Hasselt.

With regard to this form, after examining numerous examples from North America and Central America and a few from Peru, I have come to the conclusion that originally it was derived from the same stock as *tredecim-guttatus* Rossi; and that whatever small differences there are between the two now, they are the result of long separation and different surroundings. The only differences which appear to me to be constant, lie in the relative position of the eyes of the anterior row and the hairy clothing of the abdomen. It is true that the abdominal pattern is different, the lateral spots being elongate-oval, or long narrow stripes, instead of more rounded and shorter, as in *tredecim-guttatus*; but since there is every variety of coloration, from those which are entirely black, or have only the apex of the abdomen red, to those which are fully striped with red, one cannot regard colour-characters as of specific importance.

5. *LATRODECTUS CURAÇAVIENSIS* (Müller), 1776. (Plate XXVII.  
fig. 4.) (Sub-species.)

Synonym. *L. geographicus*, Van Hasselt.

The two females, referred by M. Simon to the former name, from Asuncion, and kindly lent me for examination, are adult, and represent a type of coloration often found in the immature of *L. mactans*. This form has the abdomen mainly red, with a pair of parallel black longitudinal bands posteriorly, and two or more transverse black cinctures anteriorly. The type of coloration is the same as that of some males and females which I took on the sandy campos near Santarem, on the Lower Amazons; and the latter are unmistakably like Van Hasselt's figure of *L. geographicus*, though the precise form of the coloration differs.

But, in this case again, though the Spiders are very much smaller, I am unable to find any really reliable difference in the palpal organs or in the vulva from those of *L. mactans*. Differences may indeed exist, and possibly with several dozen examples to compare, instead of two or three, one might find them.

At present, however, I can only regard this form as a dwarf race with different form of coloration, and for the time being must consider it as a sub-species.

*Hab.* CURAÇOA, West Indies (Müller); PARAGUAY: Asuncion, San Pedro and Rio Apa (Simon); SURINAM (Van Hasselt); AMAZONS (F. Cambridge).

6. *LATRODECTUS TREDECIM-GUTTATUS* (Rossi), 1790. (Plate XXVI.  
fig. 3.) (Sub-species.)

Synonyms. *L. malmignatus* Walck.—*L. martius* Aud. in Sav.—*L. argus* Aud. in Sav.—*L. venator* Aud. in Sav.—*L. erebus* Walck.—*L. lugubre* (Dufour, sub *Theridion*).—*L. oculatus* Walck.—*L. conglobatus* C. L. Koch.—*L. lugubris* Motsch.—*L. hispida* (C. L. Koch), sub *Meta*.

This is perhaps the best known form, being common all through the South of Europe, the Mediterranean region, Northern Africa, and through South Russia and Syria. It is notorious in all parts of this region for its venomous bite.

The only real distinction I can find between the "*forma principalis*" of *13-guttatus* and *mactans* is that in the female the lateral anterior eyes are further from the centrals than these are from each other, and the hairy clothing is much finer. In the males, however, there is no difference in this respect. This character (the eye-formula), moreover, is not constant in the females of either *mactans*, *tredecim-guttatus*, or *hasseltii*. I can find no tangible difference between the various parts of the palpal organs in the male, or of the vulva in the female, of these forms (*hasseltii* ♂ is unknown to me).

I believe these to be all offshoots of one original form, for which the oldest name is *mactans*.

*Hab.* EUROPE: Spain, Italy (Walck.); Greece (C. L. Koch);—



France, Morbihan; Vendée; Vaucluse, Avignon; Hérault (*Simon*);—Hungary, Croatia (*Kulczynski*);—Italy, Tuscany (*Doria*);—Sardinia, Corsica (*Walck.*, *Simon*);—S. Russia, Sarepta (*Motsch.*).

ASIA MINOR (*Simon*);—Arabia (*Dr. Anderson*);—Syria (*Simon*);—Persian Gulf, Bushire (*Moore*).

ATLANTIC ISLANDS: Canaries (*Lucas*);—Madeira, Porto Santo (*Kulczynski*, *Grant*).

AFRICA: Egypt, Alexandria (*Walck.*, *Aud. in Sav.*, *Simon*, etc.).

7. LATRODECTUS MENAVODI Vinson, 1863. (Plate XXVII. fig. 3.)  
(Sub-species.)

This form, resembling the Australian examples (*hasseltii*) in size, but having the vestiges of the dorso-lateral spots characteristic of *13-guttatus*, consisting of small red spots, is peculiar to Madagascar and the neighbouring islands. I am quite unable to distinguish the female from either *13-guttatus* or *hasseltii*, but so far I have had no opportunity of examining the male. I am inclined, however, to believe that it is simply a local variety of *13-guttatus*, the European form of *mactans*.

*Hab.* Madagascar (*Vinson*).

8. LATRODECTUS HASSELTII Thorell. (Plate XXVI. fig. 4; Plate XXVII. figs. 1, 6.)  
(Sub-species.)

Synonyms. *L. scelio* Thorell.—*L. cinctus* Blackwall.—*L. indicus* Simon.—*L. elegans* Thor.

This distinct-looking form is essentially *L. menavodi*, which has lost the small dorso-lateral spots, leaving only a narrower (Australia, etc.), or broader and foliated (Loyalty Islands), red band down the posterior dorsal central line.

*Hab.* AUSTRALIA: Rockhampton; Bowen (Port Denison); Cape York (*Thorell*);—New Caledonia (*Simon*);—New Guinea (*Turner*);—New Holland (*Kulczynski*);—Loyalty Islands, Lifu (*Creagh*);—N. Britain (*Brit. Mus.*);—New S. Wales, Hill Grove; N. Queensland, Muldiva (*Broom*); N.W. Australia (*Beckett*);—Adelaide (*Meldola*).—AFRICA: Shiré River; Zambesi (*Blackwall*); Lake Nyassa (*Brit. Mus.*); Bogos, Scioa or Shoa (*Pavesi* and *Antinori*); Graham's Town, Tea Fountain (a dark variety with only a minute red apical spot and a few black blotches), Jansenville, Cape Colony (*Brit. Mus.*). ASIA: Persian Gulf, Bushire (*Moore*); N. Guzerath; Poona; Mascat; Kurrachee (*Simon* and *Brit. Mus.*).—BURMAH (*Fea*).

9. LATRODECTUS KATIPO Powell. (Plate XXVII. fig. 5.)  
(Sub-species.)

There is a decided tendency towards a shortness of the first pair of legs amongst specimens from different parts of Africa, Australia, India, and New Zealand. This is most noticeable amongst examples from New Zealand, and, together with the tendency, the examples are as a rule smaller; and the anterior

portion of the abdomen inclines to be marked by indistinct narrow, transverse, pale cinctures, as in an example from Abyssinia; while the markings on those from New Zealand more resemble, though very indistinctly, those of *geometricus*.

In the case of these examples there are unfortunately no males. But although the first pair of legs in the New-Zealand examples are distinctly shorter in proportion than those of *L. hasseltii* from Australia, yet this character is found also, in varying degrees, amongst examples from Australia and India, so that one cannot regard it as constant.

*Hab.* NEW ZEALAND: Portland Island, Hawkes Bay (*Robson*); Canterbury (*Brit. Mus.*).

### III. *Alphabetical List of Described or Figured Species of the Genus LATRODECTUS.*

LATRODECTUS. Abbot's figures 191 ♀, 194 ♀, 195 ♀, 395 ♂ ad., 344 ♂ juv. All these are varieties of *L. mactans* Fabr. (Abbot's drawings in *Brit. Mus. Nat. Hist.* 1792).

LATRODECTUS APICALIS A. G. Butler, 1877.

*Proc. Zool. Soc. Lond.* 1877, p. 75, pl. xiii. fig. 2, etc. *Hab.* Galapagos Islands. Type in coll. *Brit. Mus.*—A variety of *L. mactans* Fabr.

LATRODECTUS ARGUS Aud. in Sav., 1825–27.

Savigny's 'Égypte,' p. 137, pl. 3. fig. 10. *Hab.* Alexandria.—This is *L. tredecim-guttatus* (Rossi).

LATRODECTUS CAROLINUS (A. G. Butler), 1877.

*Proc. Zool. Soc. Lond.* 1877, p. 75, pl. xiii. figs. 3, 3 a, 3 b. *Hab.* Charles's Island, Galapagos. Sub *Theridion*.—An immature female of *L. mactans* Fabr.

LATRODECTUS CINCTUS Blackwall.

*Ann. Mag. Nat. Hist.* (3) xvi. p. 341 (1865). *Hab.* Shiré River, South-east Africa, Zambesi. Also Bogos and Scioa (Shoa).—This species is clearly a variety of the form called by Thorell *hasseltii*. I have before me a young female from Shoa, referred by Pavesi to "*cinctus*," which agrees with Blackwall's description. The form of the markings coincides also with that of Thorell's co-type of *scelio* from Cape York, which is now before me, the only difference being that there is a single transverse bar beneath, similar to that obtaining in the form called *menavodi* and also in some examples of *tredecim-guttatus*. The shortness of leg i. in proportion to the length of the carapace brings it nearer to the *katipo* variety of *hasseltii* which is found in New Zealand, etc.

LATRODECTUS CONGLOBATUS C. Koch, 1838.

*Die Arachniden*, iv. p. 41, fig. 274. *Hab.* Greece.—A variety of *L. tredecim-guttatus* Rossi.

## LATRODECTUS CURAÇAVIENSIS (Müller), 1776.

Linn. Vollst. Nat.-Syst. Supp., Reg. Band, p. 342, 1776 (sec. Keyserling). *Hab.* Curaçoa.—E. Simon, Boll. Mus. Zool. Anat. Comp. Univ. Torino, vol. xii. no. 270, Feb. 4, 1897. *Hab.* Asuncion, San Pedro and Rio Apa, Paraguay.—This species, of which M. Simon has kindly sent me examples, is, so far as coloration goes, similar to varieties of *geographicus* Hasselt. The present name has priority.

LATRODECTUS CURASSAVICUM (Héring). *Hab.* Ozam.

(I am at present unable to indicate this reference.)

## LATRODECTUS DISTINCTUS Blackwall, 1859.

Ann. Mag. Nat. Hist. (3) iv. p. 260. *Hab.* Madeira.—Belongs, according to Thorell, to the genus *Lithyphantes*, possibly = *L. nobilis* Thor.

## LATRODECTUS DOTATUS C. Koch, 1841.

Die Arachniden, viii. p. 115, fig. 683. *Hab.* North America.—Identical, according to Koch, with *Tetragnatha zorilla* Walck. Both these forms are obviously males of *L. mactans* Fabr.

## LATRODECTUS ELEGANS Thor., 1898.

Ann. Mus. Genova, (2) xix. p. 293, ♀. *Hab.* Burmah.—Probably a variety of *L. hasseltii*; resembling *L. cinctus* Blackw., a form I have seen from Shoa.

## LATRODECTUS EREBUS Walck., 1837.

Insectes Aptères, i. p. 646. *Hab.* Egypt, Spain.—Dark variety of *L. tredecim-guttatus* Rossi.

## LATRODECTUS FORMIDABILIS Walck., 1837.

Insectes Aptères, i. p. 647, ♀. *Hab.* Georgia.—Undoubtedly *L. mactans* Fabr.

## LATRODECTUS GEOGRAPHICUS Van Hasselt, 1888.

Tijd. voor Ent. xxxi. pt. 3, pp. 165–200, pls. v. & vi. (1888). *Hab.* Surinam.—This is, so far as size and pattern of colouring, a distinct species. I have taken the adult male and female on the sandy campo, at the roots of grass and under overhanging ledges, near Santarem on the Lower Amazons. It is, however, difficult to justify the apparent specific distinction by any tangible structural difference. The form may finally be relegated to the position of a local race, and perhaps be regarded as a sub-species.

## LATRODECTUS GEOMETRICUS C. L. Koch, 1841.

Die Arachniden, viii. pp. 115–117, fig. 684.

This is perhaps one of the most distinct and easily recognizable of the species, the larger size of the anterior central eyes being constant. The colour varies from pinky grey to nearly black.

**LATRODECTUS HASSELTII** Thor., 1870.

Kongl. Svenska Akad. Förhandl, 1870, no. 4, p. 369. L. Koch, Arach. Austr. 1871, p. 276. *Hab.* New Holland; Rockhampton; Bowen (Port Denison).—This species is undoubtedly identical with *scelio* Thor.

**LATRODECTUS HISPIDUS** (C. Koch), 1836.

Die Arachniden, iii. p. 9, fig. 166. Sub *Meta*. *Hab.* Greece.—Probably identical with *L. tredecim-guttatus* (Rossi).

**LATRODECTUS HYSTRIX** E. Simon, 1889.

Ann. Soc. Ent. Fr. (6) x. p. 99 (1889). *Hab.* Yemen (*Simon*); Aden (*Yerbury*).—A very distinct species, recognizable by its straight posterior row of eyes, and abdomen clothed with short, stiff bristles.

**LATRODECTUS INDICUS** E. Simon, 1897.

Mém. Soc. Zool. Fr. x. p. 252 (1897). (*SCELIO*, var. *indica*.) *Hab.* North Guzerath.—Bull. Mus. d'Hist. Nat. no. 7, p. 289 (1897). *Hab.* Mascat, Kurrachee.—Pocock, Arach. Ind. p. 23, fig. 80 (1900). This is a variety of *L. hasseltii* = *scelio* Thor.

**LATRODECTUS INTERSECTOR** Walck., 1837.

Insectes Aptères, i. p. 649. *Hab.* America.—Undoubtedly a variety of *L. mactans* Fabr.

**LATRODECTUS KATIPO** Powell, 1870.

Trans. New Zealand Institute, iii. p. 57. *Hab.* New Zealand.—The relatively shorter legs of the first pair, and the straightness of the posterior row of eyes, in the female (I have not seen the male), would suggest at first that this is a distinct species and not identical with *hasseltii* Thor. = *scelio* Thor., but I find that this character is not by any means constant. The hairy clothing on the abdomen furnishes, however, a very good distinctive character.

**LATRODECTUS LINEATUS** (Hentz), 1850.

Boston Journ. Nat. Hist. vi. p. 281, pl. x. fig. 3.—‘Spiders of the United States,’ ed. Burgess, p. 153, pl. 17. fig. 3. Sub *Theridium*. *Hab.* North America.—A variety of *L. mactans* Fabr.

**LATRODECTUS LUGUBRIS** (Dufour), 1820.

Ann. Gén. Sci. Phys. iv. p. 355, pl. lxix. fig. 1. Sub *Theridion*.—Identical with *L. erebus* Walck. & Aud. in Sav. = *L. tredecim-guttatus* (Rossi).

**LATRODECTUS MALMIGNATUS** Walck., 1837.

Insectes Aptères, i. p. 642. *Hab.* Corsica, Sardinia, Italy.—Variety of *L. tredecim-guttatus* (Rossi).

**LATRODECTUS MARTIUS** Aud. in Sav., 1825–27.

Savigny’s ‘Égypte,’ p. 137. *Hab.* Italy (*Walck.*); Egypt.—



Variety of *L. tredecim-guttatus* (Rossi)? According to Thorell this belongs to the genus *Lithyphantes*.

*LATRODECTUS MENAVODI* Vinson, 1863.

Aranéides Réunion, etc. p. 122, pl. viii. fig. 5. *Hab.* Madagascar.—This form may be regarded as a sub-species, or local race.

*LATRODECTUS OCULATUS* Walck., 1837.

Insectes Aptères, i. p. 645. *Hab.* Alexandria.—A variety of *L. tredecim-guttatus* (Rossi).

*LATRODECTUS ORNATUS* Lucas, 1845.

Histoire d'Algérie, p. 233, pl. 14. fig. 8. *Hab.* Algeria.—According to Thorell it belongs to the genus *Lithyphantes*.

*LATRODECTUS PALLIDUS* O. P. Cambr., 1872.

Proc. Zool. Soc. Lond. 1872, p. 287 (♀). *Hab.* Plains of Jordan (*O. P. C.*); Bushire, Persian Gulf (*Kurrachee Museum*).—The two females from the Kurrachee Museum are undoubtedly identical with *L. pallidus* O. P. C. The dull yellow colour of the abdomen (which is almost entirely devoid of hairs), with the slashed pattern on the sides and the conspicuousness of the four impressed dots on the anterior dorsal area, renders it easily to be recognized from any other form. The posterior row of eyes is almost or quite straight, and the lateral anteriors are nearer the centrals than these are to each other.

*LATRODECTUS PERFIDUS* Walck., 1837.

Insectes Aptères, i. p. 647. *Hab.* Georgia.—Probably *L. mac-tans*.

*LATRODECTUS QUINQUEGUTTATUS* Krynicki, 1837.

Bull. Soc. Imp. Nat. Moscou, p. 75, tab. vi. fig. 2. *Hab.* S. Russia.

*LATRODECTUS SCELIO* Thorell, 1870.

Kongl. Svenska Vet.-Akad. Förhandl. 1870, no. 4, p. 370. *L. Koch*, Araneiden Australiens, 1871, p. 279. *E. Simon*, Mém. Soc. Zool. Fr. x. p. 252, 1897. *Hab.* New Caledonia (*François*); Muscat, Kurrachee; and North Guzerath, Central Asia (var. *indica* Sim.).—This form is undoubtedly identical with *hasseltii* Thor., the latter name taking priority.

*LATRODECTUS SCHUCHII* (C. L. Koch), 1836.

Die Arachniden, iii. p. 10, fig. 137. *Hab.* Greece. Sub *Meta*.—Thorell, Kongl. Svenska Vet.-Akad. Hand. Band xiii. no. 5, p. 68. *E. Simon*, Bull. Soc. Zool. Fr. ix. 1884, p. 21, note. *Pavesi*, Ann. Mus. Genova, xv. p. 333 (1880), Tunis. *E. Simon*, Arach. France, vol. v. p. 179 (1881), note.

I do not know this species. A male and two females, which

were kindly sent by M. Simon under this name, I am quite unable, at present, to separate from *tredecim-guttatus*. Simon thinks (Arachn. France, vol. v.) that this form may be identical with *pallidus* O. P. Cambridge.

*Hab.* Greece (*C. L. Koch*); Algeria, Spain, and Senegal (*Simon*); Spain, Torrevieja (*Thorell*); Shoa and Tunis (*Pavesi*).

*LATRODECTUS SPINIPES* Lucas, 1845.

Hist. d'Algérie, p. 233, pl. 14. fig. 9. *Hab.* Algeria (*Lucas*).—This is possibly either an *Asagena* or a *Pœcilochroa* (Drassidæ).

*LATRODECTUS THORACICUS* Nicolet, 1854.

Gay's Histoire de Chile, p. 461. *Hab.* Chili (*Nicolet*).—Probably a variety of *L. mactans* (Fabr.).

*LATRODECTUS TREDECIM-GUTTATUS* (Rossi), 1790.

Fauna Etrusca, vol. ii. p. 136, tab. ix. fig. 10.

This species is the common Mediterranean form of which *L. erebus* Walck. is the dark unicolorous black variety.

*Hab.* Italy, Corsica, Sardinia, Spain, N. Africa, Greece, S. Russia, Madeira, etc., etc.

*LATRODECTUS TROPICUS* Van Hasselt, 1860.

Tijdschrift voor Entomologie, iii. p. 46, pl. 5. *Hab.* Curaçoa.—Probably a small variety of *L. geographicus* Hasselt.

*LATRODECTUS VARIEGATUS* Nicolet, 1854.

Gay's Histoire de Chile, p. 461, pl. 4. fig. 9. *Hab.* Chili.—Probably a variety of *L. mactans* Fabr.

*LATRODECTUS VARIOLUS* Walck., 1837.

Insectes Aptères, i. p. 648. *Hab.* Georgia.—Variety of *L. mactans* Fabr.

*LATRODECTUS VENATOR* Aud. in Sav., 1825–27.

Savigny's 'Égypte,' p. 138, pl. 3. fig. 11. *Hab.* Egypt.—Variety of *L. tredecim-guttatus* (Rossi).

*LATRODECTUS VERECUNDUS* (Hentz), 1850.

Boston Journ. Nat. Hist. vi. p. 280, pl. x. figs. 1 & 2. Sub *Theridion*. *Hab.* N. America.—A dark variety of *L. mactans* (Fabr.), having the same relation to it as *L. erebus* bears to *L. 13-guttatus*.

*LATRODECTUS ZICKZACK* (Karsch), 1878.

Zeits. gesamt. Naturwiss. li. p. 311 (1878). Sub *Theridium*. *Hab.* Zanzibar.—Variety of *L. geometricus* C. Koch.

*LATRODECTUS ZORILLUS* (Walck.), 1837.

Insectes Aptères, Atlas, pl. 19. figs. 2 B, 2 d, 2 D. Sub *Tetragathe zorille*, ♂ ad.—Obviously *L. mactans* Fabr.

## IV. EXPLANATION OF THE PLATES.

## PLATE XXVI.

- Fig. 1. *Latrodectus pallidus*; Bushire: p. 253. Dorsal view of female. 1a. A portion of the integument from the lateral region of the abdomen, showing acanthoid spines.
2. *Latrodectus hystrix*; Yemen: p. 252. Dorsal view of female. 2a. Integument of abdomen, showing acanthoid and stouter straight spines.
3. *Latrodectus tredecim-guttatus*; Tuscany: p. 254. Dorsal view of female. 3a. Integument of abdomen, showing acanthoid and long curved spines.
4. *Latrodectus hasseltii*: p. 255 (co-type of *L. scelio* Thor., Cape York). Dorsal view of female. 4a. Integument of abdomen, showing acanthoid and longer spines. 4b. Dorsal view of female variety from New Britain. 4c. Another variety from the same locality. 4d. Another variety from Fort Bowen. 4e. Variety from South Australia. 4f. Variety (probably *L. cinctus* Blackw.) from Shoa, Africa. 4g. Variety from Lake Albert Nyanza, Africa.

## PLATE XXVII.

- Fig. 1. *Latrodectus hasseltii*, var. *indicus*; Kurrachee: p. 255. Dorsal view of female. 1a. Integument of central dorsal posterior red band, showing absence of acanthoid spines. 1b, 1c, 1d, 1e. Varieties from the Loyalty Islands. 1f. Integument of central dorsal posterior band, showing bristles set closer together than in var. *indicus*.
2. *Latrodectus mactans*; Mexico: p. 253. Dorsal view of female. 2a. Integument of abdomen, showing fine bristles only.
3. *Latrodectus menavodi*; Madagascar: p. 255. Dorsal view of female. 3a. Integument of abdomen, showing fine bristles of two lengths.
4. *Latrodectus curaçaviensis*; Santarem, Lower Amazons: p. 254. Dorsal view of female from Santarem. 4a. Variety from Curaçoa, almost identical in coloration with other varieties from Santarem.
5. *Latrodectus katipo*; New Zealand: p. 255. Dorsal view of female. 5a. Ditto, variety. 5b. Ditto, variety. 5c. Ditto, variety. 5d. Profile view, showing relative length of leg i. 5e. Integument of abdomen, showing fine hairs only.
6. *Latrodectus hasseltii*: p. 255. Profile view, showing relative length of leg i.
7. *Latrodectus geometricus*; Cape Town: p. 252. 7a, 7b, 7c, 7d, 7e. Dorsal view of females, varying in colour from almost white to almost entirely black, from Table Mountain.

### 3. Notes on the Painted Snipe (*Rostratula capensis*) and Pheasant-tailed Jaçaná (*Hydrophasianus chirurgus*). By FRANK FINN, B.A., F.Z.S., Deputy Superintendent of the Indian Museum, Calcutta.

[Received March 12, 1902.]

Few Waders are better known to sportsmen and to other observers of wild bird-life in India than these two beautiful species. But there is always something to be learnt from the close observation necessary to the successful retention of specimens in captivity; and as I have made a special study of examples of these two birds with a view to sending them to the Society's Gardens—in which I was fortunately successful<sup>1</sup>—I venture to record a few notes which I have been led to make concerning them.

<sup>1</sup> [Three Painted Snipes were received from Mr. Finn on January 1st, 1901, and nine Pheasant-tailed Jaçanás on January 11th, 1902 (see P. Z. S. 1902, vol. i. p. 51). —Ed.]

I. *The Painted Snipe.*

This species, although not so abundantly brought into the Calcutta Provision Market as the true Snipes *Gallinago caelestis* and *G. stenura*, is nevertheless commonly to be had during the winter, and I have kept many examples. They bear confinement well on the whole, but never become properly tame, although they will let themselves be caught more readily than most birds. This is no doubt largely due to the fact that they are in the habit of either crouching to avoid detection—their olive-green dorsal coloration, with yellow longitudinal stripes, making for protection—or of endeavouring to frighten off an otherwise unavoidable enemy by hissing and expanding their spotted wings. When only slightly alarmed they open the wings without spreading them; if still more persecuted, they expand the further wing and raise it; while, in desperation, they spread both wings and the tail, forming a most beautiful fan. Both sexes do this equally, and, so far as I can judge, make much the same sound, which is like that produced by plunging a hot iron into water. At the same time they crouch down close to the ground. I have seen them show off in this way to other birds—a Rail, a Ruff, and a Pitta, none of which were at all impressed by the display. I have, however, seen a Golden Plover (*Charadrius fulvus*) frightened thereby, although this species is bold and pugnacious with other birds.

I have no doubt that the natives who informed Hume that this was also the position assumed during courtship were correct in their statements, since in so many birds the so-called courting postures are merely those assumed on any excitement, as may be well seen in the Turkey and Muscovy Duck.

When at rest the Painted Snipe squats down with the breast on the ground and the tail up, the bill also pointed downwards. At such times the head has a smooth rounded appearance. When, however, the bird is moving about, there appear two superciliary ridges, which give the head a quite different expression and show off the magnificent dark eyes. There is also during movement an up-and-down motion of the hinder part of the body, similar to that observable in the Common Sandpiper (*Tringoides hypoleucus*), but slower.

This so-called Snipe appears never to bore for food, but it will search for it in water, or even sand, with a motion much like that of the Spoonbill. It eats grain—paddy and canary-seed—readily, the latter seeming to be best assimilated, although the former is more readily taken. It will also devour maggots, but appears not to care about worms. The flight is entirely Rail-like, and when the bird is skulking along to hide, the gait is also like that of a Rail. Like a Rail, also, the Painted Snipe swims readily, but this of course is not an important point, as the power of swimming is general among the Waders. The grain-eating habit is also common to the Ruff and Black-tailed Godwit among the family allies of *Rostratula*.



I once kept a young bird of this species, which I obtained when nearly full-fledged. It fed well on canary-seed and maggots, and I kept it till it was full-grown; but it showed no more tendency to become tame than an old bird.

I am rather astonished at Blyth's failure to keep this species alive, as I do not consider it hard to manage, except for its tendency to fly against netting and to abrade its bill by its futile attempts to escape. If kept in a cage with upright bars it is certain to hurt itself, but in a hutch with netted front, or a good-sized aviary, it will do well, and some have survived for a year at the Calcutta Zoological Gardens, though several succumbed after this on getting access to unsoaked grain.

## II. *The Pheasant-tailed Jaçaná.*

This very beautiful and graceful wader has been a special favourite of mine ever since I began seriously to study it. It is one of the most numerous-captured species during the winter, but it is not by any means easy to keep in captivity. The difficulty lies in the fact that the birds' legs and feet must be kept damp in order that they may thrive, as otherwise the skin about their hocks cracks and dries, and they become lame.

I used to turn out the birds that did not seem to be doing well on the pond in the Museum grounds, generally with clipped wings, and several lived there for some time, remaining most of the time on masses of "kalmi" or water-convolvulus. Three males are still (February) there, two of which are full-winged, but seem to have no desire as yet to go away. When standing on the weeds, they are most difficult to see from the other side of the pond, which is about sixty yards across, but on the wing they are most conspicuous objects. In this respect they much resemble the Paddy-bird or Pond-Egret (*Ardeola grayi*), which has a similar plan of coloration, with a brown upper surface and concealed white wings. Both birds have a somewhat similar flight, and, were they insects, one would probably be said to mimic the other. No doubt, however, in both birds the coloration is merely protective. When in breeding-plumage both the Egret and the Jaçaná are easy to see, especially the latter, which is a very conspicuous object in the pied livery of the nuptial season, set off by the long black tail. A female on the tank last May had assumed nuptial plumage, as had one male, while two other males and a pair of young birds still remained in undress.

The old hen would only allow one male to remain near her, this being one of the winter-plumaged adults; the full-plumaged male was not allowed to approach, and even the favoured bird, although he often drew near her in a stooping attitude, which was the nearest approach to courtship I saw, was driven off if he got too near. The birds never made any display of their beautiful white black-bordered wings, which rather surprised me. I found that the birds were distinctly pugnacious about this time, observing

boundaries strictly and attacking strangers. In fighting, they seize with the beak and strike with both wings at once. The spur with which the carpal joint is armed is only represented by a small, movable, pointed tubercle in winter, and is evidently a seasonal growth like the horns of the deer. They swim gracefully, but slowly. Of many birds turned on the pond, only two were seen to dive in trying to get away when first let out. They swam only with their wings, which are remarkably powerful, very unlike those of the Rails. The feet are very weak in grasping-power, the hallux especially only flexing at the basal joint; in the Rails the last joint flexes strongly.

There is a good deal of variation in this species. I have seen one or two specimens with particularly stout strong bills, fine old females; some, irrespectively of age or sex, are glossed with purple on the brown upper surface at all times—all show the gloss when wetted. The eyes are usually brown in adults and yellow in the young; but I have seen two quite young birds with the dark iris, and many old ones, in adult winter plumage, retaining the yellow eye. Birds showing the iris in a state of change are curiously rare.

In watching the market for years, I never saw an adult retaining its summer plumage in winter; but one of my males on the pond, which has "stuck in the moult," to use a bird-fancier's expression, has never thoroughly changed into winter dress. From observation of another of these males, I believe the quills are cast at once.

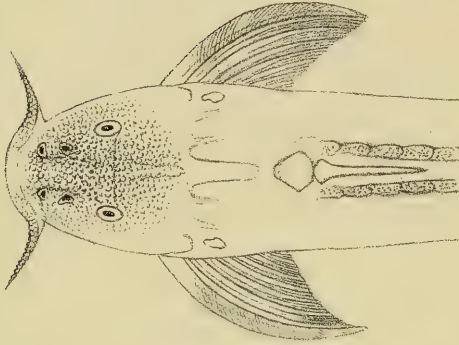
This bird does not appear to fear Kites, nor do these offer to attack it, even when sickly; perhaps they fear its strong and armed wings. It is a bold species, caring little for other birds, and not timid with man after a few days' immunity on a pond; in a cage it is not so easily reconciled, and is apt to hurt its wings at the carpal point, much as Doves will frequently do when first caged. Almost the only food I have seen taken by the birds at liberty is small water-snails about the size of peas; in captivity they will take to paddy at once, and also eat canary-seed and maggots. The grain should always be soaked for them, and their legs frequently wetted when they are confined in a cage. They never seem to feel the heat in the open, remaining in the hot sun all day long without panting.

The males are certainly better protected than the females, the greater height of which exposes their white breasts when on the low kalmi weed; but no doubt in more lush vegetation the hens also would share in the protection which the coloration affords to this most interesting bird.

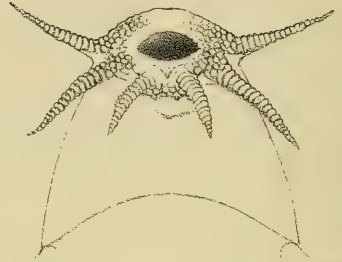




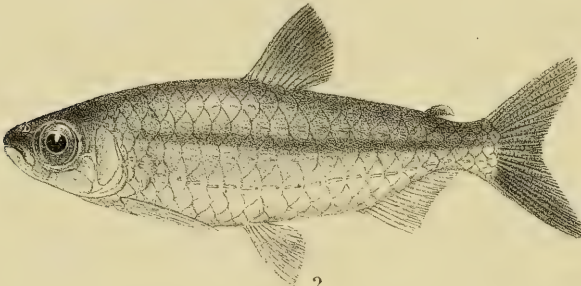
3.



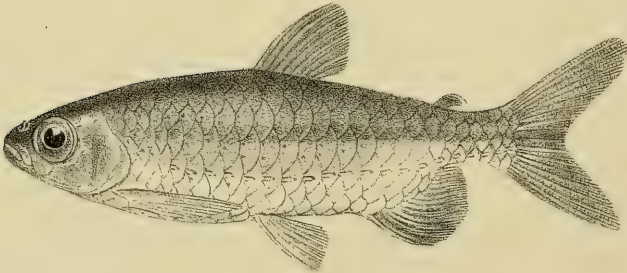
3a.



3b.



2.



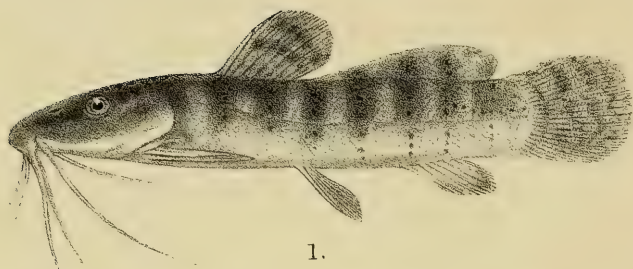
1.



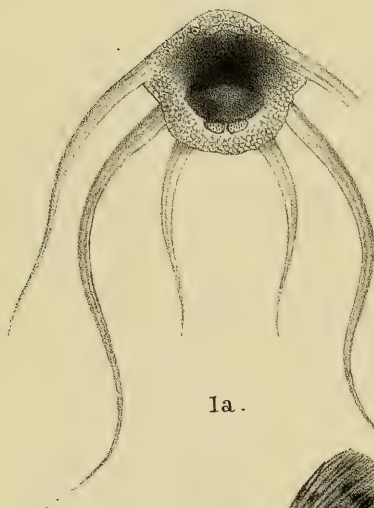




3.



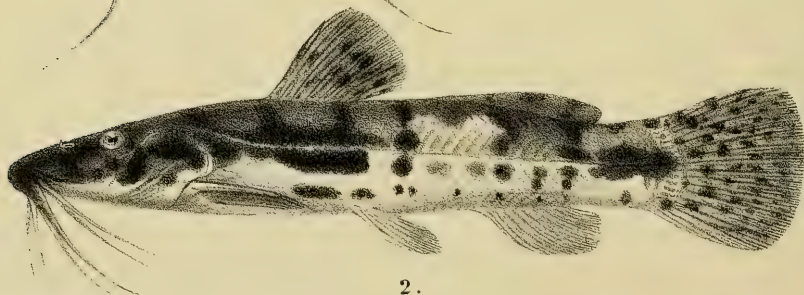
1.



1a.

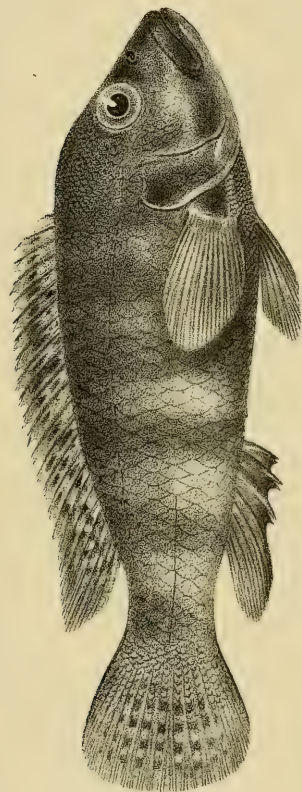


2a



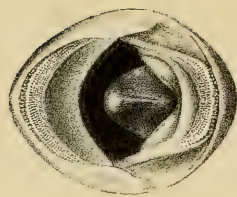
2.



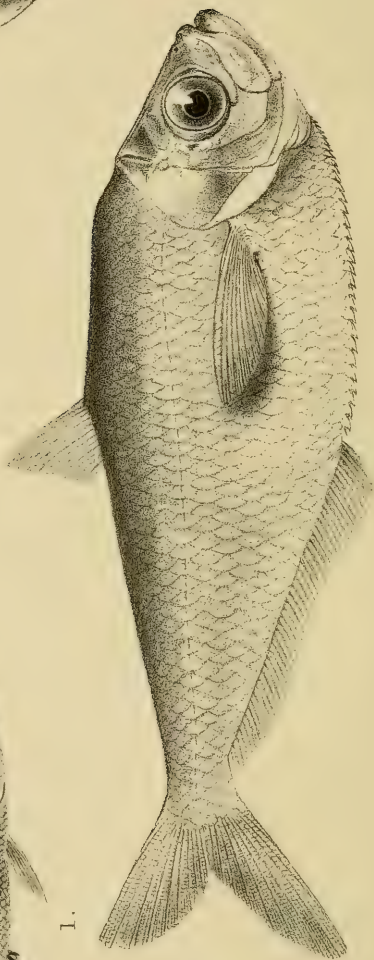


1.

2.



2a.



3.

1. PSEUDOPLESIOPS SQUAMICEPS. 2. TILAPIA STORMSI.  
3. PRISTIGASTER DOLLOI.



4. Contributions to the Ichthyology of the Congo.—II. On a Collection of Fishes from the Lindi River. By G. A. BOULENGER, F.R.S.

[Received March 17, 1902.]

(Plates XXVIII.–XXX.<sup>1</sup>)

Among the material which has been most obligingly intrusted to me for study by the Director of the Royal Natural History Museum in Brussels there is a large and important collection of Fishes made by M. Maurice Storms, a cousin of the late Raymond Storms, so well known for his important contributions to paleo-ichthyology, in the Lindi River, which flows into the Congo at the Stanley Falls. As the fauna of this river had not previously been explored, it is desirable to give a list of all the species represented in the collection, seven of which are new to science.

MORMYRIDÆ.

1. MORMYROPS DELICIOSUS Leach.
2. PETROCEPHALUS SIMUS Sauv.
3. MARCUSENIUS PULVERULENTUS Blgr.
4. STOMATORHINUS HUMILIOR Blgr.
5. MYOMYRUS MACRODON Blgr.
6. GNATHONEMUS MOORII Gthr.
7. GNATHONEMUS ELEPHAS Blgr.
8. GNATHONEMUS RHYNCHOPHORUS Blgr.

CHARACINIDÆ.

9. HYDROCYON LINEATUS Blkr.
10. BRYCONÆTHIOPS MICROSTOMA Gthr., var. BOULENGERI, Pellegr.
11. ALESTES GRANDISQUAMIS Blgr.
12. MICRALESTES HUMILIS Blgr.
13. MICRALESTES ALTUS Blgr.
14. MICRALESTES STORMSI, sp. n. (Plate XXVIII. figs. 1 & 2.)

Depth of body  $3\frac{1}{2}$  times in total length, length of head 4 times. Head longer than deep, twice as long as broad; snout shorter than the eye, the diameter of which equals the interorbital width

<sup>1</sup> For explanation of the Plates, see p. 271.

and is contained  $2\frac{2}{3}$  to 3 times in the length of the head; maxillary extending to below anterior border of eye; præmaxillary teeth 16, in two rows, the outer tricuspid, the inner quinqucuspid; mandibular teeth 8 in the outer row, tricuspid. Gill-rakers short, 12 or 13 on lower part of anterior arch. Dorsal II 8, originating above ventrals, at equal distance from the tip of the snout and the root of the caudal,  $1\frac{1}{2}$  as deep as long and about  $\frac{3}{4}$  the length of the head. Adipose fin 2 to 3 times as distant from the rayed dorsal as from the caudal. Anal III 15-16, deeper and with more convex border in the males than in the females. Pectoral longer than the ventral,  $\frac{3}{4}$  or  $\frac{4}{5}$  the length of the head. Caudal forked, with pointed lobes. Caudal peduncle as long as deep. Scales 22-24  $\frac{4\frac{1}{2}}{3\frac{1}{2}}$ , 2 between lateral line and base of ventral. Brownish above, white beneath, with a silvery lateral band.

Total length 75 millim.

Numerous specimens.

15. *DISTICHODUS FASCIOLATUS* Blgr.

16. *DISTICHODUS SEXFASCIATUS* Blgr.

17. *NANNOCHARAX FASCIATUS* Gthr.

18. *NANNOCHARAX ELONGATUS* Blgr.

19. *NANNOCHARAX TÆNIA* Blgr.

#### CYPRINIDÆ.

20. *LABEO GREENII* Blgr.

21. *LABEO PARVUS* Blgr.

22. *BARBUS KESSLERI* Sdr.

23. *BARBUS HUMERALIS* Blgr.

24. *BARILIUS UBANGENSIS* Pellegr.

*B. fasciolatus* Blgr. is identical with this species. The fascicle of the *Bulletin du Muséum* containing Dr. Pellegrin's description was not received in London until March 3rd of this year, after my description had gone to press in the *Ann. Mus. Congo, Zool.* ii. p. 34 (March 1902).

25. *CHELETHIOPS ELONGATUS* Blgr.

#### SILURIDÆ.

26. *CLARIAS ANGOLENSIS* Sdr.

27. *CLARIAS BYTHIPOGON* Sauv.

28. *EUTROPIUS CONGOLENSIS* Leach.

29. *AUCHENOGLANIS PUNCTATUS*, sp. n. (Plate XXIX. figs. 1, 1a.)

Depth of body 5 times in total length, length of head 3 times. Head smooth,  $1\frac{1}{3}$  as long as broad; snout pointed, half the length of the head; diameter of eye 6 times in the length of the head, hardly twice in the interocular width; width of mouth more than half that of the head; lips wide, papillose; posterior nostril cleft-like, a little nearer the eye than the end of the snout; præmaxillary teeth forming a short and narrow band, the mandibulars two rounded groups; maxillary barbel as long as the head, reaching the middle of the pectoral spine; outer mandibular barbel  $1\frac{1}{3}$  the length of the head, inner  $\frac{1}{2}$  the length of the head; gill-membranes forming an obtuse angle; occipital process small, as long as the eye, separated from the interneural shield, which is very small. Humeral process small, pointed. Dorsal I 7; spine smooth,  $\frac{2}{5}$  the length of the head. Adipose fin 4 times as long as deep, nearly reaching the caudal, narrowly separated from the rayed dorsal. Pectoral spine half as long as the head, its inner edge strongly serrated. Ventral not reaching the anal. Latter with 10 rays, 7 of which are branched. Caudal rounded. Pale brownish, with seven indistinct darker bars, each accompanied by a vertical series of black dots; belly white; dorsal and caudal fins with transverse series of dark spots.

Total length 80 millim.

A single specimen.

Allied to *A. ubangensis* Blgr. Differing principally in the longer maxillary barbel.

30. *AUCHENOGLANIS PULCHER*, sp. n. (Plate XXIX. figs. 2, 2a.)

Depth of body 5 to  $5\frac{1}{2}$  times in total length, length of head 3 to  $3\frac{1}{2}$  times. Head smooth,  $1\frac{1}{2}$  as long as broad; snout obtusely pointed, half the length of the head; diameter of eye 7 to 9 times in length of head, twice to twice and a half in the interorbital width; width of mouth rather more than half that of the head; lips wide, papillose; posterior nostril cleft-like, a little nearer the eye than the end of the snout; præmaxillary teeth forming a reniform group, the mandibulars two rounded groups; maxillary barbel  $\frac{2}{3}$  to  $\frac{3}{4}$  the length of the head, not extending beyond the base of the pectoral; outer mandibular barbel nearly as long as the head, inner nearly half the length of the head; gill-membranes forming an acute angle; occipital process small, as long as the eye, separated from the interneural shield, which is very small. Humeral process small, pointed. Dorsal I 7; spine smooth, half the length of the head. Adipose fin 4 to 5 times as long as deep, twice to twice and a half as long as its distance from the rayed dorsal. Pectoral spine half as long as the head, its inner edge strongly serrated. Ventral not reaching the anal. Latter with 11 or 12 rays, 7 or 8 of which are branched. Caudal rounded. Caudal peduncle as long as deep. Yellowish, brown on the back, with transverse series of round black spots; a large black blotch

on each side below the dorsal fin; belly white; dorsal and caudal fins with round black spots.

Total length 100 millim.

Several specimens.

Distinguished from the preceding species and from *A. ubangensis* by the smaller eye; from the former by the shorter, from the latter by the longer maxillary barbel.

31. *AMPHILIUS*<sup>1</sup> *BREVIS*, sp. n. (Plate XXIX. fig. 3.)

Depth of body 6 to  $6\frac{1}{2}$  times in total length, length of head  $3\frac{2}{3}$  to  $3\frac{3}{4}$  times. Head much depressed, a little longer than broad; snout broadly rounded,  $\frac{1}{3}$  the length of the head; eye very small, 9 or 10 times in length of head,  $2\frac{1}{2}$  or 3 times in interocular width; maxillary barbel  $\frac{2}{3}$  or  $\frac{3}{4}$  length of head, scarcely longer than the outer mandibular, inner mandibular about  $\frac{1}{3}$  length of head. Dorsal I 6, equally distant from the end of the snout and the root of the caudal; adipose fin once and a half to twice as long as the rayed dorsal,  $1\frac{1}{3}$  to  $1\frac{1}{2}$  as long as its distance from the latter. Pectoral longer than the ventral,  $\frac{2}{3}$  the length of the head. Anal II 6. Caudal feebly emarginate. Caudal peduncle as long as deep. Brown above, dotted with black; belly white; caudal peduncle blackish towards the base of the caudal; fins white, caudal with a large rhomboidal or cruciform black marking.

Total length 48 millim.

Two specimens.

This species is most nearly related to *A. platychir* Gthr., which differs, among other points, in having the dorsal fin nearer the end of the snout than the caudal, and the caudal peduncle longer than deep.

32. *SYNODONTIS GRESHOFFI* Schilth.

33. *SYNODONTIS PLEUROPUS* Blgr.

34. *SYNODONTIS DECORUS* Blgr.

35. *EUCHILICHTHYS ROYAUXI* Blgr.

36. *PHRACTURA LINDICA*, sp. n. (Plate XXVIII. figs. 3, 3 a, 3 b.)

Depth of body  $7\frac{1}{2}$  to 8 times in total length, length of head 5 to  $5\frac{1}{2}$  times. Head  $1\frac{1}{3}$  to  $1\frac{2}{5}$  as long as broad, nearly smooth above, covered with papillose skin; snout half length of head, obtusely pointed, projecting but slightly beyond the mouth; space between the two nostrils at equal distance from the end of the snout and from the eye, or a little nearer the latter; eye superolateral, its diameter 6 to 7 times in length of head, twice in interocular width; barbels thick and papillose, annulate, maxillary  $\frac{1}{2}$  length of head, outer mandibular  $\frac{1}{3}$ , inner mandibular  $\frac{1}{4}$ ; occipital process narrow, 4 times as long as broad, narrowly separated

<sup>1</sup> *Amphilius* Gthr. 1864, = *Anoplopterus* Pfeff.



from the small interneural shield. Dorsal I 6, first ray longest, slightly longer than the head; second dorsal very small, originating above last rays of anal, its posterior rays adnate to the back through a transparent membrane. Anal II 7-8. Pectoral a little longer than head, reaching, or not quite reaching base of ventral; latter a little shorter, reaching anal; outer ray of pectoral and ventral much thickened. Caudal with crescentic notch. Caudal peduncle much depressed,  $\frac{2}{3}$  to  $\frac{1}{2}$  total length. 23 or 24 dorsal and 18 or 19 ventral scales, of which 8 or 9 are on the caudal peduncle, the last 5 united round the latter. Yellowish brown above, speckled with darker and with four more or less distinct broad dark cross-bands; fins whitish, with brown spots forming bars across the pectorals and ventrals.

Total length 82 millim.

Four specimens.

The genus *Phractura* Blgr. was represented by three species: *P. bovei* Perugia, from the Lower Congo, of which I have lately examined three specimens belonging to the Brussels Museum; *P. scaphirhynchura* Vaill., known from two specimens from the Alima, Upper Congo; and *P. ansorgii* Blgr., recently described in these 'Proceedings' from a single example discovered by Dr. Ansorge in Southern Nigeria. The four species now known may be distinguished by means of the following synopsis:—

- |   |                                     |
|---|-------------------------------------|
| I. Occipital process not reaching interneural shield;<br>snout about half length of head.   |                                     |
| Head feebly rugose above; posterior nostril nearly as distant from the eye as the anterior from the end of the snout; diameter of eye 10 or 11 times in length of head, $2\frac{1}{2}$ or 3 times in interocular width; maxillary barbel $\frac{2}{3}$ length of head ..... | 1. <i>P. bovei</i> Perugia.         |
| Head smooth above; posterior nostril nearly as distant from the eye as the anterior from the end of the snout; diameter of eye 6 or 7 times in length of head, twice in interocular width; maxillary barbel $\frac{1}{2}$ length of head ...                                | 2. <i>P. lindica</i> Blgr.          |
| Head rugose above, with strong ridges; posterior nostril very near the eye, the diameter of which is 7 times in length of head and $1\frac{2}{3}$ in interocular width; maxillary barbel $\frac{1}{2}$ length of head .....   | 3. <i>P. ansorgii</i> Blgr.         |
| II. Occipital process in contact with interneural shield; snout more than half length of head; eye 7 times in length of head, $1\frac{1}{2}$ in interocular width; maxillary barbel $\frac{1}{4}$ length of head .....  |                                     |
|   | 4. <i>P. scaphirhynchura</i> Vaill. |

#### CYPRINODONTIDÆ.

##### 37. HAPLOCHILUS SINGA Blgr.

#### ANABANTIDÆ.

##### 38. ANABAS MACULATUS Thomin.

## CICHLIDÆ.

39. *HEMICHROMIS FASCIATUS* Peters.40. *PSEUDOPLESIOPS SQUAMICEPS*, sp. n. (Plate XXX. fig. 1.)

Depth of body  $3\frac{1}{2}$  times in total length, length of head 3 times. Upper profile of head curved; snout a little longer than the diameter of the eye, which is contained  $3\frac{1}{2}$  times in the length of the head and equals the interorbital width; mouth with broad, thick lips, extending to below anterior border of eye; 3 series of teeth in the upper jaw; occiput and sides of head with large scales; 2 or 3 series of scales on the cheek. 8 gill-rakers on lower part of anterior arch. Dorsal XVII 8; spines subequal from the sixth, barely one third length of head; longest soft rays two thirds length of head. Anal III 6; third spine longer than dorsals, two fifths length of head; soft rays like dorsals. Pectoral about two thirds the length of the head. Ventral about the same length, not reaching the vent. Caudal rounded. Caudal peduncle as long as deep. Scales cycloid, 29 in a longitudinal, 13 or 14 in a transverse series; upper lateral line on 8 or 9 scales, forming an interrupted series, lower on 3 or 4. Pale brownish above, white beneath; a dark horizontal streak on each side of the head, behind the eye; soft dorsal, anal, and caudal fins with numerous transverse series of small dark spots.

Total length 65 millim.

Two specimens.

Distinguished from *P. nudiceps* by the scales on the head, the shorter dorsal spines, and the interrupted lateral lines.

41. *TILAPIA STORMSI*, sp. n. (Plate XXX. figs. 2, 2a.)

Teeth in 4 to 7 series, outer deeply notched, inner much smaller and tricuspid; 36 to 60 teeth in the outer præmaxillary series. Depth of body equal to length of head, 3 to  $3\frac{1}{4}$  times in total length. Snout rather pointed, with straight or slightly convex upper profile,  $1\frac{1}{3}$  to  $1\frac{2}{3}$  the diameter of the eye, which is contained 4 to  $4\frac{1}{2}$  times in the length of the head and equals the interorbital width; width of mouth about  $\frac{2}{3}$  that of the head; maxillary extending to between nostril and eye; 3 or 4 series of scales on the cheek; large scales on the opercle. Gill-rakers short, some anvil-shaped, 11 or 12 on lower part of anterior arch. Dorsal XVI-XVII 9; last spine longest, about  $\frac{2}{5}$  the length of the head, about  $\frac{2}{3}$  the longest soft rays. Pectoral rounded, about  $\frac{2}{3}$  the length of the head, widely separated from the anal. Ventral not reaching the vent. Anal III 7; third spine about  $\frac{1}{3}$  the length of the head. Caudal rounded. Caudal peduncle as long as deep. Scales with strong marginal denticulation, 30-31  $\frac{2\frac{1}{2}-3}{16-17}$ ; lateral line  $\frac{21-23}{6-11}$ ; scales on the occiput and nape very small. Olive-brown above, some of the scales black at the base; 5 or 6 more or less indistinct dark cross-bands; a blackish

opercular spot; dorsal and caudal fins with small dark spots; a fine blackish edge to the caudal above and beneath.

Total length 102 millim.

Five specimens.

Allied to *T. fasciata* Perugia.

### Appendix.

In a series of specimens from other parts of the Congo State, belonging also to the Brussels Museum, the representative of a new species of a marine Clupeid genus was found, which I have great pleasure in naming after my friend and colleague M. L. Dollo.

#### PRISTIGASTER DOLLOI, sp. n. (Plate XXX. fig. 3.)

Closely allied to *P. cayanus* Cuv., but abdominal profile much less convex. Depth of body 3 times in total length, length of head 4 times. Eye longer than the snout, shorter than the postocular part of the head; maxillary extending to below the centre of the eye. Gill-rakers long, 25 on lower part of anterior arch. Dorsal 15, equally distant from the end of the snout and the root of the caudal. Anal 46, originating below the middle of the dorsal. Pectoral nearly as long as the head. Caudal deeply forked. Caudal peduncle as long as deep. About 40 scales in a longitudinal series. Ventral serration formed of 32 spinose scutes. Uniform silvery.

Total length 120 millim.

A single specimen from Banana.

### EXPLANATION OF THE PLATES.

#### PLATE XXVIII.

Fig. 1. *Micralestes stormsi*, male, p. 265.

2. " " female.

3. *Phractura lindica*, p. 268.

3 a. " " Upper view of head and anterior part of body,  $\times 2$ .

3 b. " " Lower view of head,  $\times 3$ .

#### PLATE XXIX.

Fig. 1. *Auchenoglanis punctatus*, p. 267.

1 a. " " Open mouth,  $\times 2$ .

2. " *pulcher*, p. 267.

2 a. " " Open mouth,  $\times 2$ .

3. *Amphilius brevis*, p. 268.

#### PLATE XXX.

Fig. 1. *Pseudoplesiops squamiceps*, p. 270.

2. *Tilapia stormsi*, p. 270.

2 a. " " Open mouth,  $\times 2$ .

3. *Pristigaster dolloi*, p. 271.

5. Field-Notes upon some of the larger Mammals of Patagonia, made between September 1900 and June 1901.  
By HESKETH PRICHARD, F.Z.S.

[Received March 13, 1902.]

1. THE HUEMUL. (*Xenelaphus bisulcus*.)

(*Huemul* of the Argentines and Chilians; *Ciervo* of the Gauchos of Southern Patagonia; *Shoan* of the Tehuelches.)

In the neighbourhood of Lake Buenos Aires this beautiful deer first came under my observation. On the south side of the valley of the river De los Antiguos I saw a buck (which I shot), two does and a pricket. I was informed by my Gaucho, Humphrey Jones, that the Huemul is found in the woods as far north as the Welsh Colony of the 16th October about lat. 43°, and that on the south its range extends to the Straits of Magellan. Its present habitat may be broadly said to extend as far east as the foothills of the Andes. Dr. F. P. Moreno states that the *Xenelaphus bisulcus* has been seen in the hills in the vicinity of Port Desire on the Atlantic coast; I do not, however, think it is any longer to be found there. So far as my personal observations go, I never came across a specimen farther east than a couple of miles from the shores of Lake Buenos Aires upon its north-eastern side. The Indians say that this animal was at one time more numerous in this region.

During the summer these deer leave the lower grounds where the mosquitoes trouble them, and travel up to the snow-line of the Cordillera and even beyond it. At this season I never observed a large herd; but in the winter, Mr. Cattle, a pioneer living near Lake Argentino, informed me that a numerous herd, over 100 strong, had visited the lake.

The Huemuls are in the habit of wandering outside the forests in the morning and forenoon, but in the afternoon they generally retire to their shelter, where they often lie down. I have found these animals in the dense forests upon the slopes of the Cordillera which border the lakes. They are excellent swimmers, and cross the broad arms of Lake Argentino without hesitation.

In December the Huemuls which I shot were shedding their winter coat, and I noticed that the bucks were further advanced in this matter than the does. There were a few scraps of velvet clinging to the horns of one of the bucks which I shot on the 17th of December.

The best head that I secured carried 5 points. Mr. Von Plaaten Hallermund, of the Argentine Boundary Commission, told me that he had seen a Huemul's head carrying 8 points; this was in the neighbourhood of Lake San Martin. One of my peones, Bernardo Hahansen, who had penetrated into the same district, said he also had seen an 8-pointer. Mr. Cattle and his companions shot two bucks, both of which were 4-pointers.



Save for the attacks of the Pumas, *Xenelaphus bisulcus* lives pretty well undisturbed in its fastnesses. The Indians do not hunt the Huemul, as in the forest-land their horses and *boleadores* are comparatively useless. They do occasionally kill a few, which may have strayed to the foothills and to the shores of the lakes.

These deer, which know little of man, are in general very confiding. Near the Colony of the 16th October, Jones told me that they had become very wary and difficult of access, as was to be expected in a region where they are constantly hunted. In the unpenetrated districts the buck is very courageous in the rutting-season, and has been known to make some show of attacking man. On open ground, according to my experience, they showed wonderfully little timidity, and would wait the approach of man, but inside the forests they invariably dashed away on catching a glimpse of one of our party.

When it has observed something unusual in its surroundings, the Huemul will remain watching and without moving for a great space of time. On one occasion, I saw near Lake Argentino a buck and doe about a quarter of a mile away. I lay under a bush, watching some wild cattle, and the Huemuls stood and watched me for nearly an hour. They were about 10 yards apart. On my returning to the same spot in the evening, I found them still watching my horse, which I had tied up in their view.

In one or two instances, when I fired at a Huemul, the others of the herd have run towards the noise. Once this occurred when I was in full sight of the animals. If, however, you have a dog with you, they will immediately take to flight.

Musters, in his 'Travels in Patagonia,' mentions a "red" deer. Of this I could find no trace; so that I conclude that he probably referred to *Xenelaphus bisulcus* under this name.

## 2. THE PUMA. (*Felis concolor puma*.)

(*Lion* of the English settlers; *Leon* of the Argentines, Chilians, and Gauchos; *Gol* of the Tehuelches.)

The distribution of *Felis concolor puma* extends over the entire country of Patagonia. It is to be found in the Cordillera as on the pampas. I came upon tracks of this animal at the end of the north-west arm of Lake Argentino, about long. 73° 14', and I also saw a Puma at the south-western extremity of that lake. Evidence of their existence accompanied the whole itinerary of the expedition throughout the entire route it covered. The number of Pumas in Patagonia is very great, more so than any traveller has as yet given any idea of. Two pioneers killed 73 in one winter near Lake Argentino. Near San Julian immense numbers are yearly destroyed, but now, owing to the advent of settlers, their numbers are decreasing. At Bahia Camerones, on the farm of Mr. Greenshields, 14 Pumas were killed during the winter of 1900.

A female killed near Santa Cruz measured 6 feet 10 inches; and a male killed near Lake Argentino, 8 feet 1 inch.

In strong contradistinction to the habit of *Felis onca*, *Felis concolor puma*, when hunting, kills a number of animals from a flock or herd. To only one of these kills, however, does it return, and it always makes some pretence of burying the victim singled out for its meal, throwing up upon the body in many cases merely a small bunch of thorns. This habit of the Puma is frequently taken advantage of by the shepherds, who poison the chosen carcass. The Puma, in ninety cases out of a hundred, makes its first meal upon the entrails of the victim, or upon the inside of the thigh by the groin. Another point in connection with the predatory habits of the Puma is the fact that it will travel a long distance, even as much as ten or twelve miles, after killing.

Its method of attack, judging from an examination of its kills, appears to be to spring upon the shoulders of its quarry and to break the neck. The destruction wrought by Pumas among flocks of sheep is immense. One Puma is said to have killed from a single flock upwards of 100, its total for a night amounting to 14. Cases are reported of Pumas having attacked horses; and sometimes a herd of cows, with their calves, take up the trail of a Puma with a great deal of lowing, but do not follow it far. *Felis concolor puma* usually selects a tempestuous night for its depredations upon the herds. Authentic instances of their having attacked man are few. Dr. F. P. Moreno tells me that on the bank of the River Leona, not far from Lake Viedma, he was attacked by a Puma. He was walking, wrapped up in a Guanaco skin *capa*, and he fancies the animal mistook him for a Guanaco. The Puma was killed by his companions, and was found to be in milk. Its cubs, however, were not discovered. Mr. Arenberg, of the Argentine Boundary Commission, was also attacked by one of these animals in the neighbourhood of Lake Buenos Aires. I have no details of the occurrence beyond the fact that he was wounded in the face. These two instances must be regarded as exceptional, for the Puma is ordinarily a very cowardly animal, and many are killed yearly with the *bolas* or lasso.

The Puma can easily be galloped down, as it rarely runs more than 300 yards or a quarter of a mile when pursued on horseback. It invariably stands at bay with its back to a bush or rock.

Darwin writes that "the Puma is a very silent animal, uttering no cry even when wounded, and only rarely during the breeding-season." In the forests upon the slopes of Mount Buenos Aires near Lake Argentino, one moonlight night, two Pumas circled round our camp, and for upwards of an hour kept uttering their peculiar cry. On no other occasion during our marches, although Pumas often stampeded the horses and left plain tracks of their presence close to the camp, did I hear them break silence.

### 3. PEARSON'S PUMA. (*Felis concolor pearsoni*.)

On my return from Patagonia, I brought with me a skin of a Puma, which seemed to me to differ in some essential respects

from any known species. Mr. J. G. Millais, on examining the skin, agreed with me, and pointed out that it possessed several characteristics which do not occur in *Felis concolor puma*. I took the skin to the Natural History Museum, where Mr. Oldfield Thomas came to the conclusion that the animal was a sub-species of *Felis concolor puma*, and named it *Felis concolor pearsoni*.

The chief points of difference between *Felis concolor puma* and *Felis concolor pearsoni* are as follows:—The very different general colour of *Felis concolor pearsoni*, being reddish fawn instead of silver-grey; the proportionately very short tail; light instead of dark colour on the backs of the ears, which are, moreover, more sharply pointed in the case of *Felis concolor pearsoni*; and the absence of dark markings round the digital pads.

Several Gauchos, settlers, and Indians informed me that there were two kinds of Puma in Patagonia, one being very common, grey in colour, and very cowardly. The other they described as rare, much fiercer, of a reddish colour, and somewhat smaller than the grey common species. Among the 73 Pumas killed by the English pioneers near Lake Argentino, one, Mr. Cattle told me, differed very much from the ordinary Puma, and, judging from the description he gave of it, I have no hesitation in concluding that it was a specimen of *Felis concolor pearsoni*.

#### 4. THE GUANACO. (*Lama huanachus*.)

(*Huanaco* of settlers, Argentines, and Chilians; *Rou* of Tehuelches.)

During the whole course of our travels in Patagonia (save when in the forests) a day rarely passed without our seeing Guanacos. They may be met within a few hours' ride of any settlement. The range of the Guanaco extends all over the plains of Patagonia. In my experience they were most numerous in the Cañadon Davis, in the neighbourhood of Bahia Camerones, and on the high basaltic tablelands to the south of Lake Buenos Aires. At the base of the Cordillera, and in some of the river-valleys under the edge of the mountains, the range of the Guanaco crosses that of the Huemul. I do not think, however, that the Guanaco ever enters the forest: although I have seen them in the open patches amongst the lower wooded parts of the Cordillera. As the seasons change they move from lower to higher ground, but these migrations are limited; and a white Guanaco has been observed year after year in the same neighbourhood. During the time I spent at Lake Argentino—from 1st February to 15th May—I saw but few of these animals, for at that season all the herds migrate to the high pampa. A herd 300 or 400 strong inhabited the higher plateaus of Mount Frias.

FitzRoy, in his "Voyages of the 'Adventure' and the 'Beagle,'" writes:—

"Do the Guanacos approach the river to drink when they are

dying? or are the bones and remains of animals eaten by lions or by Indians? or are they washed together by floods? Certain it is that they are remarkably numerous near the banks of the river (Santa Cruz), but not so elsewhere."

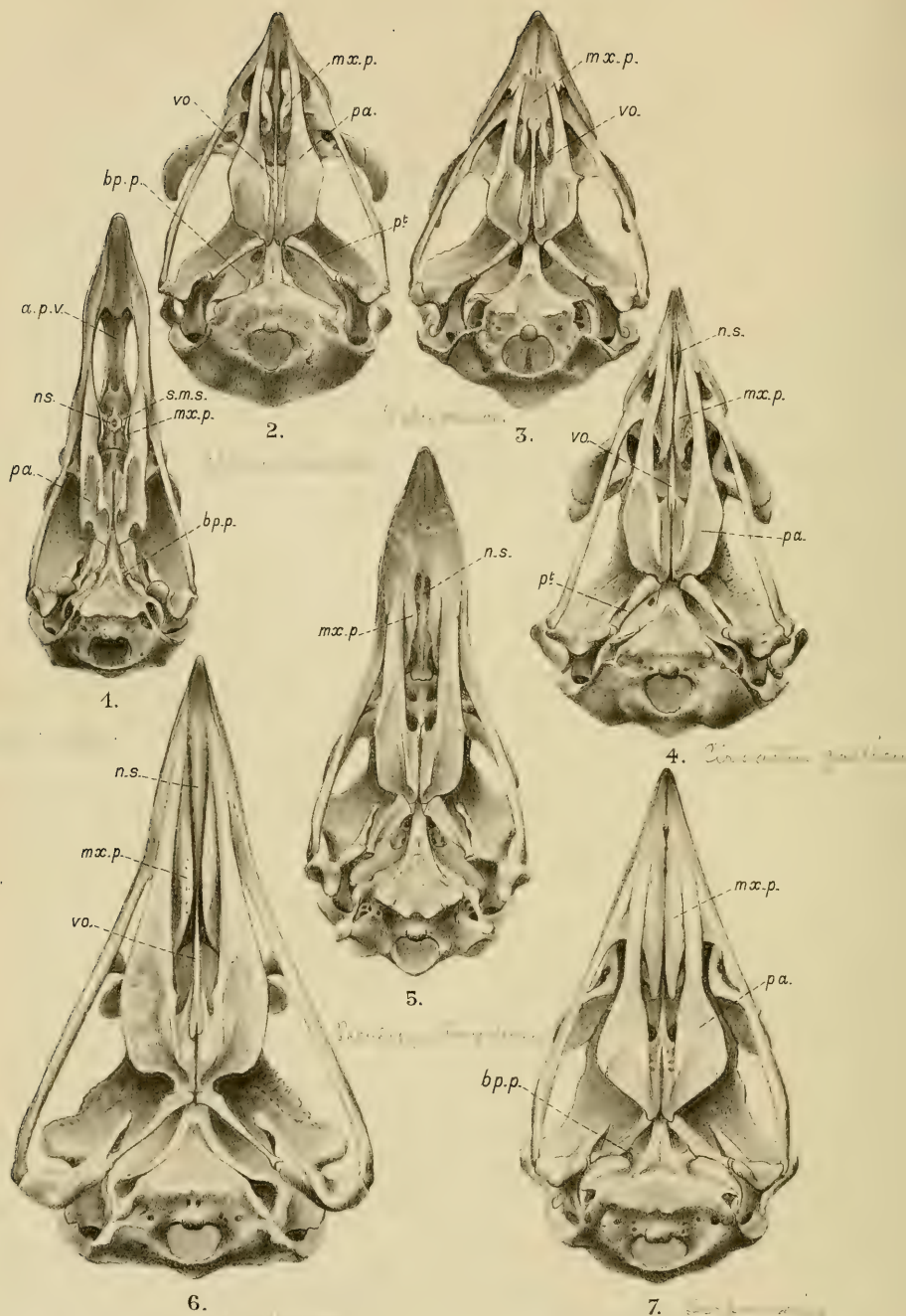
It is true that, although one comes upon skeletons of these animals upon the pampas, they are not crowded together as they are in the cañadones or by the lakes near water. At the edge of a lagoon at the eastern end of Mystery Plain a great number of skeletons were to be seen. They extended in a wide track down the hillside and to the edge of the water. At Lake Viedma the margins of the lake, near the outflow of the River Leona, were covered with their skins and bones. The meaning of this I gathered from Mr. Ernest Cattle. He told me that in the winter of 1899 enormous numbers of Guanaco sought the Lake Argentino, and died of starvation upon its shores. In the severities of winter they seek drinking-places where there are large masses of water likely to be unfrozen. The few last winters in Patagonia have been so severe as to work great havoc among the herds of Guanaco.

At nightfall Guanacos gather into close order, a large herd collecting in a small radius. They seem to choose open spaces in which to pass the hours of darkness. In moments of danger also they pack together densely. At the sound of a shot, the outlying members of a herd will close up and sway their long necks almost to the ground in unison. I see that Darwin says that Guanaco are "generally very wild and wary." In places where they are hunted by the Indians this is no doubt the case, but on this point no law can be laid down. In some districts the Guanaco is very difficult of approach: in others extremely easy. Their instinct of curiosity is very largely developed. During our wanderings I studied the habits of the Guanaco with ever increasing interest. In cold weather they become extraordinarily tame, and will permit a man to walk among them as a shepherd walks among his sheep.

The young are brought forth in the months of October, November, and the early part of December. In Southern Patagonia some are born as late as the end of December. During the period of copulation the bucks fight a good deal. I never shot an old buck which was not seamed and scarred with the marks of these contests. When fighting they give vent to loud squeals of rage; they kick with their fore feet and bite savagely, mostly at the neck of the antagonist. The marks of these bites are often deep and long. The skin of the neck is very thick. As has been noted before, the Guanacos drop all their dung in one spot, and near these spots their wallows are ordinarily to be found. I saw an old buck spend a long time over his toilet while his wives looked on and waited. He would pass nearly half an hour on his back with his legs in the air, at intervals standing up to neigh, and then rolling again.



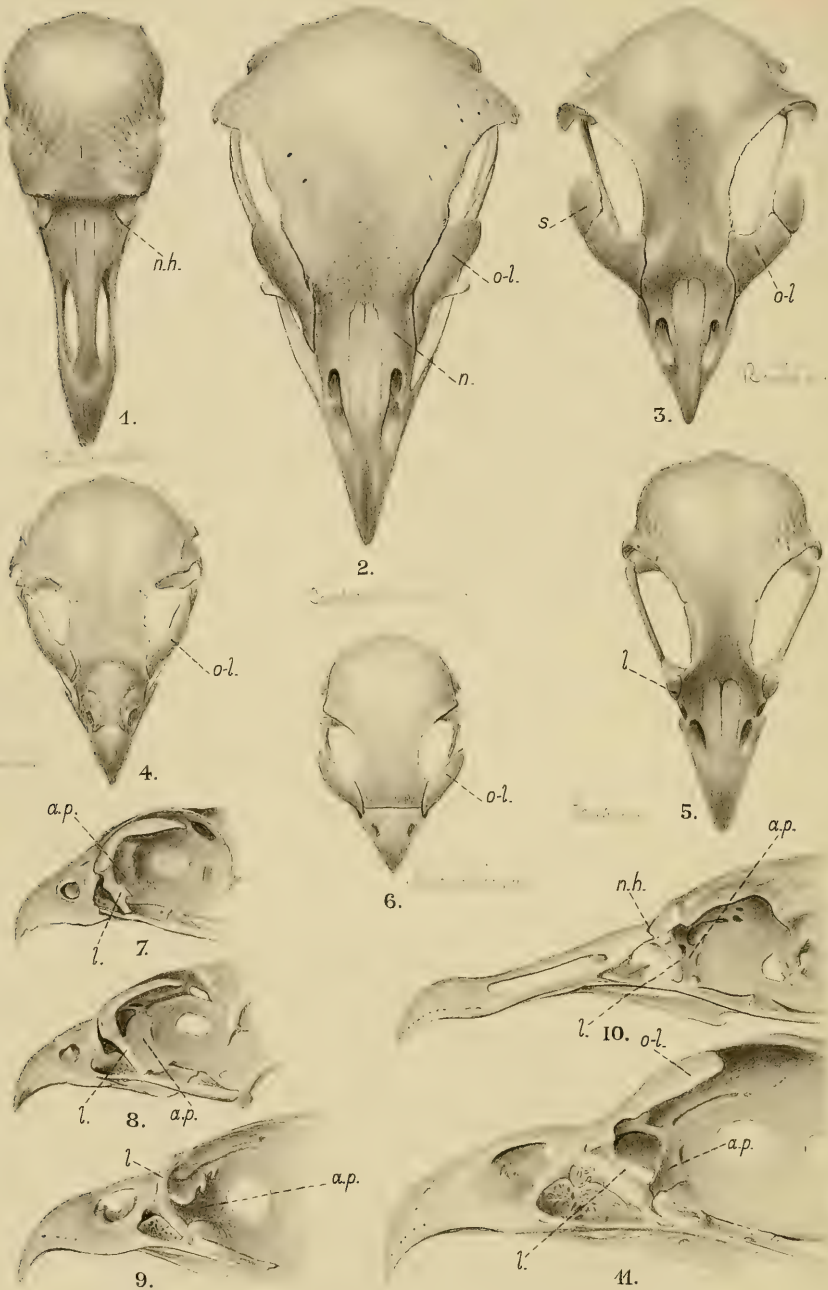




H. Grönvold. del. *Gypine. d. m.*

Photogravure by Bale & Danielsson Lm





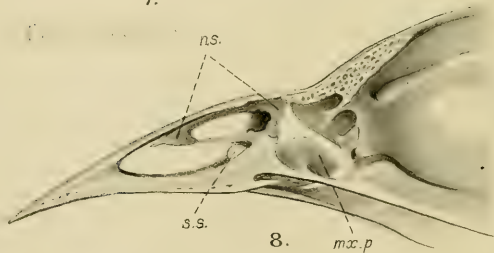
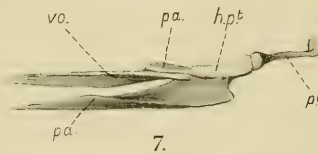
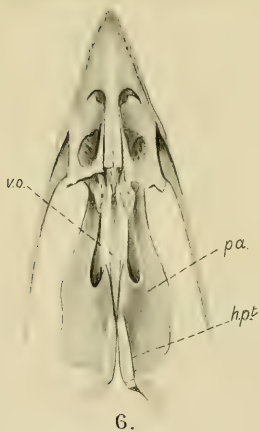
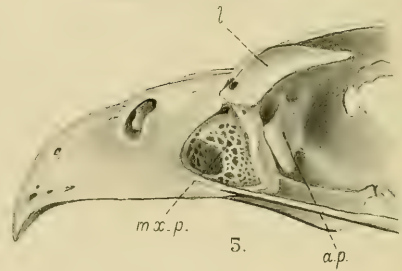
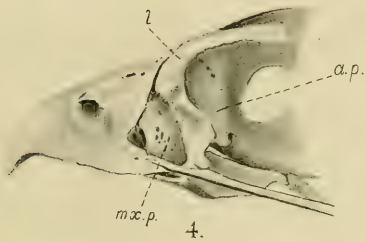
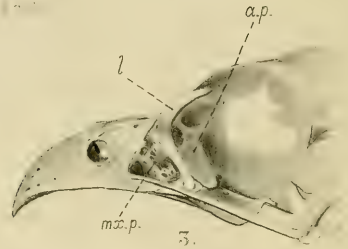
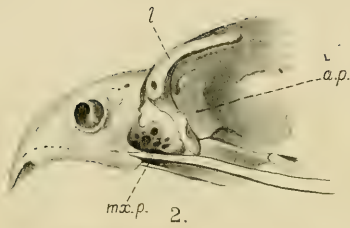
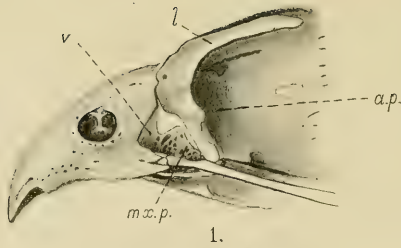
H.Grönvold, del.

Photogravure by Bale & Danielsson L<sup>ds</sup>.

OSTEOLOGY OF THE FALCONIFORMES.







H.Grönvold.del. *Pernis ptilorhynchus*

Photogravure by Bale & Danielsson L<sup>da</sup>

5. PATAGONIAN CAVY. (*Dolichotis patagonica*.)

(Called "*Cavy*" or "*Hare*" indiscriminately by the English settlers; *Liebre* by the Chilians and Argentines; *Paahi* by the Tehuelches.)

The River Deseado forms the southern limit of the distribution of the Patagonian Cavy. In 1833, Darwin writes, concerning the Cavy: "They are found as far north as the Sierra Tapalguen (lat. 37° 30'), and their southern limit is between Port Desire and San Julian, where there is no change in the nature of the country." So far as my experience goes, I never observed a Cavy after 23rd October, upon which day I counted fourteen upon the pampa between Lake Musters and the settlement of Colohaupi. The residents at Colohaupi informed me that that place formed the southern limit of distribution of the Cavy. It is of course impossible to lay down an exact line, but I think I am safe in saying that the range of the Cavy does not extend south of the 46th parallel. This limit is the more remarkable inasmuch as the country south of lat. 48° does not in any way materially differ from that over which the Cavy is commonly to be met with. It is upon patches of dry mud that these animals are most often to be observed.

6. LITTLE ARMADILLO. (*Dasypus minutus*.)

(*Pichy* of the Chilians and Argentines; *Ano* of the Tehuelches.)

This Armadillo is never found south of the River Santa Cruz. During the four months I spent south of that river I did not see one, but when, for three days, we crossed to the north bank, we met with four and killed one. *Dasypus minutus* is very common in the vicinity of the Bahia Camerones. I saw no specimen in the forests of the Andes, but near Lake Buenos Aires and Lago Viedma we found them at the foothills.

## 6. Contributions to the Osteology of Birds.

Part V. *Falconiformes*<sup>1</sup>. By W. P. PYCRAFT, F.Z.S., A.L.S.

[Received March 4, 1902.]

(Plates XXXI.-XXXIII.<sup>2</sup> & text-figures 33-37.)

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v. The Sternum and Pectoral Girdle, p. 296.	Falconiformes, p. 318.
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## i. INTRODUCTORY REMARKS.

The anatomy of the Falconiformes presents many characters in

<sup>1</sup> For Part IV. see P. Z. S. 1899, p. 1018.

<sup>2</sup> For explanation of the Plates, see p. 319.

common with certain of the Grues on the one hand, and of the Steganopodes and Herodiones on the other.

It will be the aim of the present paper to supplement the evidence of these affinities which has been so far collected; by a careful study of the Osteology of the Falconiformes,—a study which shall embrace comparisons of the skeletons of the forms not now regarded as allies of this group. By these means it may be possible to arrive at more definite conclusions concerning the probable inter-relationship of the undoubtedly allied forms, and of their phylogeny.

## ii. THE SKULL OF THE ADULT.

It seems to be impossible to draw up, in concise terms, any definition which shall serve us to readily distinguish the skull of the Falconiformes from any skull of what we are agreed to regard as the near allies of this group. This is due partly to the fact that the group contains some very aberrant forms with peculiar skulls, and partly to the fact that the characters upon which we are wont to rely for taxonomic purposes present us with many grades of perfection even amongst the smaller divisions of the group. Thus, the palate affords a series of gradations between complete desmognathism and complete schizognathism; basipterygoid processes may be very well developed or completely absent; the lachrymal may be free or fixed; the nares may be pervious or impervious; and so on.

The best that we can do is to say that no indirectly desmognathous Falconiform skull owes this form of desmognathism to the intervention of the vomer alone—as in the Cariamidæ. Again, no indirectly desmognathous Falconiform skull combines this form of desmognathism with a large vomer and a large anterior palatal vacuity. No Falconiform skull has supra-orbital grooves, or has the palatines fused in the middle line posteriorly. Finally, all the skulls of this Order have an ossified orbito-sphenoid.

The resemblances which the skull of the Falconiformes presents, through certain of its members, to the Steganopodes, Grues, and Striges will be pointed out and discussed in the following remarks.

### *The Occipital Region.*

The plane of the occipital foramen varies, from an oblique angle to one almost parallel with the long axis of the skull. The forms in which the plane is almost horizontal are those which represent the higher types—the Eagles, Buzzards, and Falcons. The foramen in these forms thus looks downwards, instead of downwards and backwards.

In the Falcons, Buzzards, and Cathartæ there is a prominent cerebellar dome. This is less well-marked in the Vultures and Eagles, and in *Serpentarius*.

The *supra-foraminal ridge* is fairly well-marked in every



member of the group. It is continued downwards on either side to form the inner border of the processus alæ exoccipitalis inferior (paroccipital process, *auct.*).

The *lambdoidal ridge* is always single and has an undulating outline. It is continued outwards for some considerable distance, when it suddenly bifurcates, one branch running directly outwards and forwards to terminate at the superior angle of the exoccipital wing, at its junction with the squamosal process; and one directly downwards and outwards to lose itself in the free border of the exoccipital wing near its middle. In *Serpentarius*, *Polyboroides*, and the Vultures the upper and outer branch is barely perceptible or wanting. In *Cathartæ* there is a deep notch between the bifurcation, so that it appears, at first sight, to be wanting. We may probably regard this as the more primitive form, since the filling-in of this notch seems to have been to increase and perfect the tympanic aperture. Beneath the lambdoidal ridge, and on either side of the cerebellar prominence, lies a well-marked depression, the supra-occipital fossæ. The latter appear to be best developed in the Falcons. In the *Cathartæ* they take the form of wide channels.

The exoccipital wing is continued downwards into the *processus alæ exoccipitalis inferior* of Sushkin (paroccipital process, *auct.*). These will be found most strongly developed in the *Cathartæ*.

The exoccipital wings are much more developed in the Striges, where the upper and outer portion of the wing is developed on either side into a prominent, outstanding flabellum.

*The cranial roof* (Pl. XXXII.).—The cranial roof is never marked by supra-orbital grooves.

In *Serpentarius* (Pl. XXXII. fig. 2) the interorbital region is widened by long, horizontal, backwardly-directed lachrymal processes, the inner borders of which are closely applied to the frontal, but do not fuse therewith. In the *Cathartæ* (Pl. XXXII. fig. 1) there would appear to have been similar processes, but these have now fused completely with the frontal, a row of foramina only indicating their line of junction.

In the *Accipitres* (Pl. XXXII. fig. 3) these horizontal processes are free, and project on either side of the head, above the orbits. In the *Buteonidæ* there is a small free plate of bone attached by ligament to the end of the horizontal process—the superciliary plate. This plate is probably a remnant of the supra-orbital chain of ossicles such as occurs in some *Palæognathæ*, e. g. *Tinamus*, *Struthio*, and in *Psophia* among the *Neognathæ*. Both the horizontal process and the superciliary plate have undergone great reduction in the Vultures, *Gypohierax* alone retaining a small remnant of the accessory plate. This same reduction of the horizontal process is also a marked feature in *Polyboroides*, wherein it is almost suppressed; the descending process of the lachrymal, it may be mentioned in passing, is very long and slender. The lachrymal of *Pandion* has undergone still further degeneration, having fused completely with the frontals and

antorbital plate (prefrontal). The horizontal process is practically suppressed.

The fronto-parietal region in *Gypohierax*, *Aquila*, *Falco*, *Polyborus*, and *Milvus*, the parietal only in *Polyboroides*, *Buteo*, and *Haliaëtus*, is marked by a shallow median groove. This groove is more or less traceable in all the Accipitres save the *Cathartæ* and *Serpentarius*. It is especially noticeable in the forms just enumerated. In the *Cathartæ* the roof of the skull presents an evenly rounded surface. The width across the skull at the fronto-parietal region in no case approaches that of some Owls, e. g. *Bubo*, owing to the smaller size of the postorbital processes.

The fusion of the nasals with the frontals is complete, and leaves no trace of the line of junction.

### *The Base of the Skull.*

The basitemporal plate in *Serpentarius* only is visibly thickened by pneumatic tissue. In the remaining members of this group it is a thin triangular plate with a slightly concave ventral surface. Posteriorly it is bounded, in the middle line, by a more or less well-marked precondylar fossa. It extends outwards on either side as a wing-like plate to join the inferior wing of the exoccipital process, in *Serpentarius*, Eagles, Buzzards, Falcons, and Vultures, for instance. But in the Osprey this junction with the exoccipital—completing the mouth of the tympanic cavity below—is formed only by a thin bar of bone. In certain Vultures and in the *Cathartæ* the hinder angles of this plate appear to terminate in a pair of prominent mammillary processes. They are the dominant features of this region of the plate, and by their great size have come to lie behind the actual posterior angles. The two sides of this triangular plate may have sharply defined free edges, e. g. in *Aquila*, in which case the Eustachian channels are open grooves; or they may be partly fused with ossified connective tissue forming the anterior wall of the recessus tympanicus anterior, when the grooves are partly closed, e. g. *Serpentarius*, *Haliaëtus*, *Buteo*; or they may fuse throughout with the inferior border of the wall forming the above-mentioned recess, leaving only a small Eustachian aperture at the apex of the triangle, as in the *Cathartæ* and *Polyboroides*, for instance. In the *Cathartæ* the parasphenoidal rostrum immediately above this aperture is deeply excavated. This is especially marked in *Sarcorhamphus*.

The parasphenoidal rostrum may or may not bear basipterygoid processes. These are largest in *Serpentarius*, where they lie at the base of the rostrum. In the *Cathartæ* they may be either short and broad, as in *Catharistes* and *Gypagus*, or very slender and seated further forward on the rostrum, as in *Pseudogryphus* and *Sarcorhamphus* (Condor). This greater slenderness evidently marks the first stages in their decay. In a skull of *Sarcorhamphus*

in the collection of the British Museum the left process is smaller than the right, and both almost fail of their purpose, not only in this species but throughout the genus. They present within the Order every degree of degeneration, from the prominent pillars of *Serpentarius* to the most minute prickles.

Traces of the anterior basicranial fontanelle are often present.

*The Lateral Surface of the Cranium.* (Plate XXXIII. figs. 1-8.)

The *tympanic cavity* attains its greatest size in the Falcons. It may be studied in its more primitive form in such examples as *Polyboroides*, *Pandion*, *Pernis*, and the Vultures. The lateral occipital wings which bound this cavity behind in *Polyboroides* are but feebly developed. The free border, on either side, terminates in a blunt and low prominence behind and slightly above the level of the *processus zygomaticus*, and marks at the same time the lower and hindmost extent of the temporal fossa. In *Pandion* the free border of this wing, which is still feebly developed, slopes obliquely backwards and upwards to the level of the *processus articularis squamosum*, then turns sharply forwards to terminate in the process itself. *Pernis* resembles *Pandion* in this respect, but neither the backward slope nor the forward angle is so marked. In *Serpentarius* and the Vultures, e. g. *Neophron*, *Gypohierax*, and *Gypaëtus*, the free edge of this wing is of greater extent, and projects as a slightly raised ridge beyond the zygomatic process. [In *Gyps* the form of the lateral occipital wing is drawn backwards and downwards to terminate in a prominent *processus alæ exoccipitalis inferior* (paroccipital process), and thus in this respect differs from *Neophron*, where the wing is more feebly developed and slopes from before backwards and upwards.] In *Buteo* the ridge laterad of the zygomatic process is much more prominent. In *Haliaëtus* and *Aquila* it has increased still more. In the Falcons it forms a thin laminate plate, rising upwards to the level of the base of the zygomatic process of the squamosal, the free edge of which is turned forwards. In the development of this portion of the exoccipital it bears a strong resemblance to the Striges, e. g. *Bubo*.

The roof of this cavity is formed by the under surface of the *processus zygomaticus squamosi*. Its floor, in part by the lateral occipital wing, and in part by the ossification of tissue extending between this wing and the external angles of the basi-temporal plate. In front it is bounded by the quadrate.

Within this cavity, in the dried skull, are two large apertures which may be considered separately. The first lies near the roof of the cavity and separates the squamosal and otic articular surfaces of the quadrate. The aperture leads upwards and backwards, so as to form a space between the anterior vertical and horizontal canals of the internal ear and the lateral occipital wing. This is the *recessus tympanicus superior*—the temporal recess of my earlier papers.

The second and lower aperture is divided from the first by the



articular surface for the otic head of the quadrate. Within it lie several foramina and the mouths of two pneumatic cavities. The foramina are the foramen ovale and the foramen rotundum, the foramen for the 7th nerve, and the foramina of the sinus petrosus. The pneumatic apertures are, as already stated, two in number. The first, and largest, opens into the mouth of the tympanic cavity at its antero-ventral angle. It may be traced inwards, and forwards, as a tubular recess leading into the parasphenoidal rostrum, terminating in the pituitary region. The anterior wall of this recess—the *recessus tympani anterior*—is formed in its larger exterior portion, as is shown by Suschkin<sup>1</sup>, by ossification of connective tissue extending in the young skull between the alisphenoid above and the basisphenoid below. When the Eustachian grooves are closed, they form two additional and much smaller apertures, opening one on either side, into the tympanic cavity, below the mouth of this anterior tympanic recess. The second of these apertures is that of the posterior tympanic recess. It is very small and not easily seen. If carefully looked for, it will be found as a small hole, lying caudad of the foramen ovale and foramen rotunda. It leads into a small pneumatic cavity lying below the horizontal semicircular canal, and between this and the inferior border of the lateral occipital wing.

The separation of the squamosal and otic articular surfaces for the quadrate by the aperture of the superior tympanic recess is a point of some interest. In the *Palæognathæ* the *recessus tympani superior* is represented by a shallow cavity, lying *behind* the articulation for the head of the quadrate. The roof of the cavity is pierced by numerous small pneumatic apertures leading from a mass of diploë lying between, and above, the horizontal semicircular canal and the brain-case. The external wall of this diploid tissue is formed by the parietal and lateral occipital bones. In some *Dinornithidæ* there is a small aperture connected with this mass of pneumatic tissue lying in *front* of the articulation for the quadrate. In the *Neognathæ* the aperture of the superior tympanic recess lies—in *Steganopodes*, *Tubinares*, and *Sphenisci*, for instance—in front of the quadrate articular surface. But in the *Accipitres* and *Striges*, for instance, it would seem that the separate anterior and posterior apertures, lying on either side of the articular surface for the quadrate, in the *Dinornithidæ*, have here become confluent, and now form one large aperture dividing the squamosal and otic articular surfaces for the quadrate far from one another. In the *Sphenisci*, by reason of the great depth of the temporal fossa lying immediately above, the greater part of this recess has become suppressed, only the lower end now remaining. In the *Pygopodes* the relatively greater depth of the temporal fossa, coupled with a general and marked tendency for the suppression of pneumatic tissue throughout the skeleton, have combined to obliterate the superior tympanic recess altogether.

<sup>1</sup> "Zur Morphologie des Vogelskelets," *Nouveaux Mém. de la Soc. Imp. des Naturalistes*, 1899.



*The Squamosal Prominence.*—In the more primitive forms, such as *Serpentarius*, *Polyboroides*, and *Pernis*, the squamosal prominence is very feebly developed. As usual, its inferior surface affords a glenoid cavity for the articulation of the squamosal head of the quadrate. Mesial of this glenoid cavity is the aperture of the superior tympanic recess. The zygomatic process is very small; in *Serpentarius* it is wanting.

The squamosal prominence is seen at its best in the Falconidæ (including *Polyborus*), where it projects conspicuously from the skull-wall. The zygomatic process is excessively developed in *Polyborus*, where it hangs downwards, eaves-fashion, over the quadrate. In addition to this, is a second and equally large process depending from the antero-lateral angle of the lateral occipital wing, at its junction with the zygomatic process.

The postero-inferior angle of the squamosal, in *Polyboroides* and in the Falcons, develops a large, downwardly-directed and pointed spike—the *processus articularis squamosi*. Between this and the zygomatic process just described, the squamosal head of the quadrate is tightly grasped. In *Serpentarius*, the Eagles, *Pernis*, *Pandion*, *Buteo*, *Circus*, *Gypaëtos*, and many of the true Vultures, for instance, this articular process is but feebly developed. In *Cathartæ* it is wanting.

The *temporal fossæ* are for the most part but shallow, linguiform depressions in the parietal region of the skull, and which never extend backwards to meet the mid-dorsal line. In *Serpentarius* they are exceedingly shallow and scarcely rise above the level of the base of the postorbital process. They are best developed in the Falcons and *Polyborus*, where they extend inward to within a short distance of the cerebellar prominence.

The *trigeminal* foramen is completely isolated, lying far removed from the mouth of the superior tympanic recess, and considerably in front of a line drawn transversely through the skull across the squamosal head of the quadrate.

The *orbits* are large. In *Serpentarius* they are protected from above by wide overhanging ledges formed by the frontal bones, behind, and by large, horizontal, backwardly-directed, flattened plates developed by the lachrymal, in front. These, one on either side, fit closely to the frontal. In the higher Accipitres the width of the interorbital region of the frontals is much less, the free edge forming a deep hollow. In this case the horizontal process of the lachrymal is left as an isolated spur projecting on either side of the roof of the skull and overhanging the orbits. In the majority of such cases, the length of the spur is increased by the addition of a separate scale-shaped ossicle—the superciliary ossicle. This is attached to the lachrymal by connective tissue. In the Falcons and Vultures it fuses with the lachrymal. In the *Cathartæ* the supra-orbital limb of the lachrymal is suppressed, the lachrymal itself fusing completely with the frontal.

The *orbito-sphenoid* is completely ossified in all the Falconiformes.

The *interorbital septum* is pierced only in the lower members of the various groups of Falconiformes. For instance, in *Serpentarius* and *Cathartes*, in *Pandion* and *Pernis*, *Polyborides*, *Gypohierax*, and the lower Vultures and Eagles.

*The Ethmoidal Region.*—The *mesethmoid*, as in Neognathæ generally, is, as it were, obliquely truncated at its anterior end, so that its free edge slopes upwards and forwards. This is due probably to the shortening of the parasphenoidal rostrum. This shortening process is very conspicuous in the Accipitres. It rarely, if ever, extends forwards beyond the level of the lachrymals in any Neognathæ. In the Palæognathæ this rostrum extends forwards for a considerable distance in front of a line drawn transversely through the skull across the lachrymals. The mesethmoid extends backwards, as in all other birds, to fuse with the orbital plate of the frontal, and the orbito- and presphenoid, and the parasphenoidal rostrum below; thus forming the interorbital septum referred to above. From the neighbourhood of its truncated anterior border springs, on either side, a more or less extensive wing-like process—the *prefrontal* or *antorbital* plate.

The *prefrontal* is somewhat feebly developed in *Serpentarius*, *Polyboroides*, and *Pernis*, for instance. In Cathartæ and in the Falcons it is much larger; in the latter it extends outwards to afford a more or less extensive lateral support for the lachrymal. In the former, the lachrymal and prefrontal relations become still more intimate, since they fuse one with another.

The *preorbital region* of the mesethmoid expands dorsad into a broad horizontal plate underlying the anterior ends of the frontals, the nasals and the nasal processes of the premaxillary. In the Vultures, Eagles, and Cathartæ markedly, and in the majority of the Accipitres to a less extent, the free edges of the horizontal aliethmoidal plate turn downwards and inwards, and finally backwards, to join the prefrontal; thus forming an ossified olfactory chamber. This is most perfectly developed in the Cathartæ, where the chamber is of very considerable extent, recalling that of the Tubinares. In *Serpentarius*, the Falconidæ, and Buteonidæ, this ossified olfactory chamber is extremely reduced. In the two latter forms perhaps the great development of the prefrontal may be regarded as filling the place of the ossifications of the horizontal plate.

The olfactory nerve, in leaving the skull, generally travels along a groove in the dorsal border of that portion of the mesethmoid which forms the interorbital septum; sometimes this groove is covered in by the ossification of connective tissue, *e. g.* Cathartæ.

I would revert once again to the comparison between the olfactory chamber of Cathartæ and that of the Tubinares. In the former the free edge of the horizontal aliethmoidal plate turns downwards on either side mesiad of the lachrymal, so as to leave a considerable space between itself and the lachrymal, to form the Harderian fossa. Furthermore, it would seem that the

aliethmoidal extensions of this plate extend backwards so as to form a complete olfactory chamber leading backwards directly, tunnel-wise, into the brain-cavity, through the apertures for the olfactory nerve.

In the Tubinares we have a very similar olfactory chamber, but of far greater size. This is due to the fact that the prefrontal, which is enormous, arises so far back that the interorbital septum is reduced to a small ring of bone surrounding the interorbital fenestra. Furthermore, the backward position of the prefrontal has involved it in the formation of the lower lateral segment of the aperture for the olfactory nerve, which may also be legitimately described as enormous. The upper lateral segment of this circular aperture is formed by the downturned edge of the horizontal aliethmoidal plate. Normally, in Neognathæ, the olfactory nerve leaves by a small foramen pierced through the free edge of the orbital plate of the frontal and the perpendicular plate of the mesethmoid, runs in a groove along the dorsal border of the plate, and thence gains the olfactory chamber. In the instance we have just examined, the olfactory aperture opens *directly* into the chamber.

It is possible that the conditions which obtain in the Tubinares may represent a primitive stage, the olfactory chamber having been pushed forwards by the great development of the orbits, demanded by the increasing size of the eye. In *Apteryx*, where the eyes are very small, the olfactory cavity is in close juxtaposition with the brain-case. The fact that the chamber is of still greater relative size, and very complicated internally, only indicates a further specialization of the primitive condition. In the Palæognathæ we may trace several stages in the forward shifting of the olfactory chamber correlated with increased size of the eyes and orbits; as a study of the skulls of *Dinornis*, *Struthio*, *Dromæus*, *Rhea*, and *Tinamus* will show.

The development of the olfactory cavity is a point which will evidently repay further investigation.

The nasal septum is divided by a considerable gap, or cleft, from the mesethmoid. This cleft, the cranio-facial fissure, is widest ventrally; the mesethmoid and nasal septum being in contact immediately below the nasal processes of the premaxilla. In the Cathartæ alone among the Falconiformes, the external nares are pervious, only the proximal portion of the nasal septum being present. This, in *Pseudogryphus californianus*, extends forwards for a short distance to encroach upon the external narial aperture, and is pierced by a round fenestra. This posterior portion of the nasal septum, in Cathartæ, expands to form a broad base which, extending outwards on either side, joins the widely separated maxillo-palatine processes, and so converts a schizo- into an indirectly desmognathous palate. In many of the true Vultures, e. g. *Gyps*, by the ossification of the alinasal ectoethmoidal wall, the nostril, in the dried skull, is of the same shape as in life. The olfactory region of the nasal labyrinth, in *Gyps*, is provided

with an ossification of the basis of the *choncha media* which projects into the cavity from the outer wall. In the true Falcons the ossification of the alieithmoid causes the anterior nares to be round in form as in life, in *Polyboroides* crescentic. In both, the aperture displays within its mouth a small median bony papilla—the papilla of the *conchæ vestibulum* of Suschkin, the alinasal turbinal of W. K. Parker. The details of the structure of the cartilaginous nasal labyrinth and its ossifications have been exhaustively worked out and beautifully illustrated by Dr. Suschkin in his masterly monograph on the skull of *Tinnunculus*.

*The Cranial Cavity.*—The *metencephalic fossa* of the Falconiformes is more basin-shaped in the smaller than in the larger forms. Moreover, in these smaller forms the anterior region of the fossa is tilted upwards and backwards so as to form an acute angle with the long axis of the skull. The *trigeminal foramen*, in *Falco* for instance, is sharply cut off from the mesencephalic fossa by an overhanging ledge of bone. The orbito-nasal foramen also lies immediately under this ledge. In the Vultures, the upper ledge of bone overshadowing these apertures is less extensive, so that they come to lie partly in the floor of the mesencephalic fossa. The apertures of the vagus and internal auditory meatus do not offer any very important points of difference for comment.

The *cerebellar fossa* is sharply defined and variable in relative proportions, being, for instance, larger in *Falco* than in *Vultur* or *Circus*. The *floccular fossa* is, in *Falco*, cordiform, and apparently rather shallower than in other forms.

The *mesencephalic fossa* is very sharply defined. It is banded above by a broad overhanging ledge formed by the tentorial ridge. The distinctness of its inferior border is blurred, in *Vultur*, by the apertures of the trigeminal and orbito-nasal nerves, which lie in the floor of the fossa. In *Falco* these are shut off from this fossa by a bony shelf, and open inward into the dorso-lateral border of the metencephalic fossa.

The *pituitary fossa* is deep and tubular, and passes almost vertically downwards. The hinder boundary of this fossa, the *dorsum sellæ*, forms a narrow ridge passing forwards and upwards to terminate above the oculo-motor foramen. The anterior border of the fossa is bounded by the transverse pre-pituitary ridge, which passes forwards into a narrow, sometimes triangular, optic platform, on either side of which lie the optic foramina. The optic platform is continued upwards, forwards, and backwards into the *pre-optic ridge* which may be traced, in *Circus* for instance, on either side into the tentorial ridge. In the majority of other forms, probably, it disappears before reaching this, e. g. *Vultur*, *Falco*.

The *oculo-motor* lies immediately caudad and ventrad of the optic foramen. It is continued backwards in a rather wide groove into the *dorsum sellæ*. Below and anterior to this foramen is the aperture for the internal ophthalmic artery—when this is separate. It opens into the pituitary fossa some distance from the



aperture for the internal carotid. The pathetic lies dorsad of the oculo-motor foramen, and may be continued backwards and downwards by a groove terminating above the orbito-nasal foramen.

The *cerebral fossæ* do not lie altogether in front of, but rather exhibit a tendency to overlap the cerebellar fossæ. The lateral extension of the cerebral fossæ is very marked. The fossæ are conspicuously depressed dorso-ventrally. This is most noticeably so in *Falco*: the distance between the point where the right and left tentorial ridges converge to join the median bony falx and the prominent triangular bony boss which bounds the mesencephalic fossa posteriorly being considerably less than in *Vultur*.

The *olfactory fossæ* are represented by a small median pit leading forwards into two narrow apertures for the optic nerves.

### *The Premaxilla.*

The *premaxilla*, in all the Falconiformes, is more or less distinctly hooked at the tip. In length and stoutness it varies.

In the Falcons and *Polyborus* it is short and wide and much hooked. The tomium, in Falcons, is notched, or rather is provided with a distinct "tooth." The palatal surface in both Falcons and *Polyborus* is extensive and marked by a well-defined median ridge, passing backwards in the maxillo-palatine processes. This ridge is faintly represented in *Serpentarius*.

In many Vultures, the palatal surface of the premaxilla is more or less deeply hollowed (Plate XXXI. fig. 5); the excavation being most noticeable in the larger forms. In others, where the breadth is slender, the palatal surface is but slight, passing rapidly backwards into a groove filled by the ventral border of the nasal septum.

In the majority of the Falconiformes, the palatal surface of the premaxilla resembles that of the smaller Vultures—is slight, bifurcate, and filled by the ventral surface of the nasal septum.

The Cathartæ differ markedly from all the other Falconiformes in the form of the palatal surface of the premaxilla. In these last the body of the premaxilla is very highly pneumatic; a section thereof revealing a mass of cancellated tissue between two dense plates of bone. This increase of pneumatic tissue brings the palatal surface down close, or very near to, the level of the tomium. In the Cathartæ this pneumatic tissue is almost wanting, so that the palatal surface comes to form a vaulted chamber. The resemblance in the structure of the premaxilla to the Tubinares is very striking.

The fusion of the nasal processes of the premaxilla with one another and with the nasals is very complete in all the Falconiformes.

In *Microhierax* the beak articulates with the skull by means of a fronto-nasal hinge as in Parrots and some other birds.

In the Cathartæ the fused lachrymal and frontal combine to



form, with the nasal bones, a more or less perfect fronto-nasal hinge, see also p. 291. There is no transverse hinge as in *Microhierax* or in Parrots.

### *The Maxillo-Jugal Arch.*

The maxilla is indistinguishably fused with the premaxilla. The maxillo-palatine processes have slowly increased in size so as to convert what was originally a schizognathous into a desmognathous palate. Many intermediate stages in the course of this transformation have been preserved and will be discussed forthwith.

In the study of the transition of the palate from the schizognathous to the desmognathous type, we will commence with *Elanus*: this form being regarded by Dr. Suschkin as exhibiting more primitive characters than any other Accipitrine bird.

In *Elanus* then (Pl. XXXI. fig. 2) the maxillo-palatine processes turn inwards in the form of a pair of small, very pneumatic, hamulate processes. Although they hem-in the vomer on either side, they do not extend so far inwards as to touch it. Distad of the vomer they are hidden by the palatines, and thus leave a large median palatal vacuity exposing the nasal septum above and lying in the middle line. The maxillo-palatine processes themselves are pierced, laterad of the palatines, and between these and the tomium, by a large foramen. The palate, however, of *Elanus* is not, I think, to be regarded as primitive, but specialized (see p. 313). *Circæetus* (Pl. XXXI. fig. 4) is also schizognathous, and probably represents the intermediate type of palate which has given rise, by specialization, in one direction to the palate such as is found in *Elanus* and the Cathartæ, and in the other to such as obtains in the Vultures and Falconidæ.

In *Aquila* (e. g. *A. chrysaëtos*, *A. audax*), *Spilornis*, and *Thrasaëtus harpyia* we find the maxillo-palatines greatly increased in size antero-posteriorly, and extending inwards mesiad of the palatines: so much so as to almost completely fill up the space between them. The nasal septum is now visible only through a narrow palatine clink. This increase in bulk has now caused the maxillo-palatines so nearly to approach one another, that they almost, if not quite, touch. But they are yet distinct, and the palate must accordingly be regarded as schizognathous.

In *Serpentarius* they touch throughout the greater part of their length, concealing the nasal septum (Pl. XXXI. fig. 7).

Indirect desmognathism, brought about by the downward extension of the nasal septum, obtains in the majority of Accipitres, and can best be studied in such forms as *Elanoides*, *Pandion*, Vultures. In *Gypaëtus* and *Neophron*, for example, the maxillo-palatines do not meet in the middle line, and but for the nasal septum would be bounded anteriorly by a large palatal vacuity as in *Cathartes*.

Direct desmognathism is perhaps only found in Falconidæ.

In all the desmognathous palates the maxillo-palatine processes remain free posteriorly.

In the Cathartæ we have a palate of quite peculiar type (Pl. XXXI. fig. 1). The maxillo-palatines, as in *Elanus*, are relatively small. But whilst, in *Elanus*, it will be remembered, they were of a spongy texture, in Cathartæ they are represented by a shell-like lamina with its concavity downwards. The external lateral border of this lamina is anchylosed with the nasal. The antrum is represented by a small cavity at the extreme anterior extremity of the plate. These shell-like laminae fail to meet in the middle line; nevertheless the palate must be regarded as of the indirect desmognathous type on account of the fact that the nasal septum expands ventrally into a horizontal plate, fusing on either side with a pair of strap-shaped laminae arising from the inner dorsal border of the maxillo-palatine processes (=the anterior septo-maxillary spur, *Parker*). Distad of the maxillo-palatines and nasal septum is a large anterior palatal vacuity roofed only by the nasal processes of the premaxilla. This region of the jaw recalls that of the Tubinares. But the palate of the Tubinares differs in the absence of an ossified nasal septum and the great size of the vomer.

The jugal is wanting from the quadrato-jugal arch in the Falcons. It is certainly present in *Accipiter*, and perhaps in other Accipitres.

In some examples of *Hierofalco* the quadrato-jugal bar is connected with the maxilla by a distinct joint. The maxilla contributes towards this articulation a backwardly directed, columnar bony process, which immediately overhangs the extreme posterior angle of the tomium. Seen from below, the articulation is transverse in form. From above, it is concealed by a spike of bone from the quadrato-jugal, which projects forwards into the mouth of the antrum. The sporadic formation of a joint in this position seems to me a point of some considerable interest.

#### *The Vomer, Palatine, and Pterygoid.*

The vomer in the Accipitres is never a very large bone. It is blade-shaped when completely developed, and sometimes is slightly bifurcated at its extreme posterior end—seen from the ventral surface. Its base is received between the anterior borders of the dorsal laminae of the posterior expanded end of the palatine: sometimes fusing therewith, e. g. *Serpentarius*. In the Falcons the vomer terminates in a bilobate expansion which rests upon the fused maxillo-palatine processes, between their free posterior projections. In *Polyborus* and *Milvago* this expansion is barely perceptible. In *Milvus* (e. g. *M. ater*), *Haliastur*, *Pernis*, and *Buteo* (e. g. *B. jakal*) the vomer is long and slender, and anchyloses with the maxillo-palatines. In *Aquiline* the vomer extends far forwards between the maxillo-palatines, but remains perfectly distinct therefrom.

In the Vultures the vomer appears to be wanting, save in *Gypaëtus*, where it is large. In *Neophron* and *Gypohierax* vestiges remain, and it may be that these traces are lost in maceration in other skeletons. In the remaining Accipitres it is either vestigial or wanting.

The *palatine* perhaps more nearly resembles that of *Cariama* than any other. It extends forwards as far as or slightly beyond the level of the external narial apertures, running beneath the maxillo-palatine process. It increases gradually in width from before backwards, reaching its maximum expansion at a point immediately below the prefrontals. From this point backwards it comes into relation with the parasphenoidal rostrum; the palatine of the right and left sides combining to form a narrow, very shallow trench, gliding up and down the rostrum with the movements of the facial apparatus. That portion which is connected with the rostrum is somewhat scroll-like in form, the free anterior edge of the scroll passing downwards and forwards into the mesial border of that portion of the palatine which is continued forwards to terminate below the maxillo-palatines as a rod- or rather strap-shaped blade. Seen from below, it would seem as if the scroll-shaped region of the expanded palatine plate were caused by a grooving out of substance of the palatine itself, causing a deep median trough, bounded on either side by a sharply-defined ridge representing the mesial border of the palatine, e. g. *Elanus* and *Serpentarius*. In other Accipitres, in varying degrees, this ridge projects downwards and forms a more or less conspicuous keel. This keel is especially strongly marked in the Falconidæ.

The *pterygoid* in the lower forms, e. g. *Serpentarius*, *Cathartes*, bears an articular surface for the basipterygoid process. In the Accipitres it forms either a cylindrical or twisted rod-shaped bone. The adult palato-pterygoid articulation is of the typical Neognathine type in all but *Pandion*. In *Pandion* the anterior end of the pterygoid is Y-shaped, the external fork of the Y articulating with the external postero-lateral angle of the palatine. This is, so far as I am aware, a quite unique feature; but nevertheless a quite secondary character, and in no way comparable to the forked pterygoid of *Apteryx*.

The maxillo-jugal bar in the Cathartæ furnishes some interesting matter for study, in certain peculiar features connected with its anterior end. These features may be traced through a series of stages gradually increasing in complexity, and associated with a gradually developing fronto-nasal hinge.

In *Cathartes* (*C. aura*) this bar, when it reaches the middle of the lachrymo-nasal fossa, splits into a long inferior dorso-ventrally depressed lamella and a superior shorter rod-shaped portion, which extends forwards to within a short distance of the maxillary process of the premaxilla. [In one skull (1186 *b*) in the Museum Collection, on the left side, the terminal portion of this maxillary process, it should be mentioned, is segmented off to form a very small separate triangular ossicle.]

In *Catharistes* the fission of the bar takes place much further forward than in *Cathartes*, and the short superior segment is abruptly truncated and roughly articulates with the aforesaid maxillary process of the premaxilla.

In *Gypagus* this inferior limb remains much as in *Cathartes* and *Catharistes*, but the superior limb now forms a shorter but laterally compressed lamina with a hollow anterior border fitting into the rounded posterior border of the maxillary process of the premaxilla.

In *Pseudogryphus* and *Sarcorhamphus* the short, laterally compressed upper limb now forms a spatulate process, working in opposition to a shallow depression in the maxillary process of the premaxilla.

The gradual development of these peculiar articulations seems to have gone hand in hand with the development of a nasal hinge, formed by a deep notch hollowed out of the anterior border of the lachrymal, for the reception of a "tooth-shaped" process borne by the outer border of the nasal. This forms the hinge; the necessary movement of the beak upon the skull is afforded by the elasticity of the nasal and premaxillary processes lying mediad of the right and left notches. This hinge is most perfect in *Gypagus*, *Pseudogryphus*, and *Sarcorhamphus*. In *Catharistes* the lachrymal is only barely perceptibly notched. A further study into the origin of structures like the present would prove profitable. Are they to be ascribed to kinetogenesis?

The composition of the quadrato-jugal bar, as revealed by an immature skull of *Cathartes*, is interesting, and chiefly on account of the large share which is borne by the maxilla. This, together with the jugal, extends backwards as a long slender bar to within a short distance of the quadrate articulation. The jugal terminates anteriorly to meet, and sometimes articulate with, the maxillary process of the premaxilla, and apparently in *Pseudogryphus* and *Sarcorhamphus*, for instance, becomes much broadened to make the articulation the more complete. The quadrato-jugal appears to terminate at about the middle of the inner aspect of the bar. A slightly older skull of *Serpentarius*, but still showing traces of sutures, agrees very closely with what has just been described in *Cathartes*. The great backward extension of the maxilla appears to be a Neognathine character.

#### *The Mandible.*

The mandible of the Accipitres is truncated posteriorly, and has a very long internal angular process. It very closely resembles that of the Bubonine section of the Striges, so much so as to require very careful discrimination. In comparing mandibles of these two groups, it will be found that among the Accipitres the two rami form a less open angle one with another, and the ventral aspect of the internal angular process is not marked by a median ridge. The lateral vacuity in the mandible



of the Accipitres is wanting save in the Falconidæ, wherein it is conspicuous. It differs, however, from that of the Striges (1) in that the coronoid extends forwards along its whole length, and (2) in that there is a small foramen lying immediately behind and above the vacuity for the passage of the mandibular branch of the trigeminal. Furthermore, the external lateral border of the articulare develops a strong upward and backwardly directed hook-like process forming a deep notch between itself and the extreme postero-lateral angle of the jaw.

In the Striges, the Bubonidæ have the coronoid terminating in a spike-like fashion near the middle of the lateral mandibular vacuity. In the Strigidæ the vacuity is much smaller; and the coronoid terminates in front of it, in a truncated and spatulate process. The V-shaped angle of the jaw is similar to that of the Accipitres; but the internal angular process is relatively more feeble, and the inferior border of the jaw is sinuous, whilst in the Accipitres it is nearly straight.

### *The Hyoid.*

The basihyal is partly ossified; short ceratohyals are also represented. The basibranchial has a diamond-shaped body continued backwards into a long style, representing the 2nd basibranchial (urohyal). The ceratobranchials are long. The epibranchials are more than half as long as the ceratobranchials.

### iii. THE VERTEBRAL COLUMN.

All the presynsacral vertebræ are heterocœlous. In all, save the Falconidæ and Polyboridæ, the thoracic vertebræ are free. In the two families just mentioned all the thoracic vertebræ are ankylosed save the penultimate, which is free. *Herpetotheres* is the only exception to this rule, having all the thoracics free.

The cervical vertebræ are relatively thick and short, and have in the larger forms a somewhat swollen and massive appearance. The ankylosed cervical ribs, which are present in all but the atlas and axis, never extend backwards as far as the end of the centrum. The anterior lateral border of each is produced upwards into a flattened plate, forming the outer wall of the vertebrarterial canal. This pleurapophysial lamella is short antero-posteriorly, its posterior border never extending as far backwards as the middle of the centrum. The dorsal border of this lamella never unites with the centrum to enclose a fenestra opening immediately behind the posterior zygapophyses, as in *Cariama* for instance. Neural spines take the form of low median tubercles: in the smaller forms these are but feebly developed. In the 2nd to 4th vertebræ the neural spines are moderately long and columnar, especially in the Falcons; the posterior angles of the 2nd and 3rd turn upwards into blunt tubercular hyperapophyses. In *Pandion* the neural spines are obsolete, but the

hyperapophyses are particularly well developed. The 2nd to 4th vertebræ bear hypapophyses: beyond these they are replaced by catapophyses, which near the cervico-thoracic vertebra again give place to hypapophyses. These catapophyses never coalesce to form a carotid canal. In many of the larger Accipitres the cervical vertebræ from say the 5th to the 8th have the neural plate deeply excised posteriorly, so that the postzygapophyses appear, each as an articular facet at the extremity of a long beam. The ventral surface of the centrum is either flattened or slightly grooved.

There is a very close similarity between the cervical vertebræ of the Accipitres and the Striges: so close is this resemblance that the one is hardly distinguishable from the other. The chief differences appear to be in the fact that the cervical ribs of the Striges are relatively slightly longer and the catapophyses somewhat more sharply defined. The pleurosteal lamella is also somewhat more band-like and sharply defined. The hyperapophyses of the axis are abruptly truncated in the Owl, tubercular in the Accipitres. For the rest, the differences are not greater than those which normally obtain between species or genera, at most.

The cervico-thoracic vertebræ may be two or three in number.

The thoracic vertebræ, as already remarked, are free save in the Falconidæ and Polyboridæ. When free, they may be distinguished from those of the Strigidæ in that the neural spines are relatively lower, wider antero-posteriorly, and not markedly inclined forward. Hypapophyses in the Strigidæ do not extend beyond the second vertebra: in the Accipitres with free vertebræ to the third. In the Strigidæ there may be a large pneumatic aperture between the articular surfaces for the capitulum and tuberculum, and a second caudad of this. As in the Accipitres so in the Striges, each transverse process sends forward and backward a long slender spike from its extreme lateral border; each spike overlaps similar spikes from the vertebra next in front and behind it. The neural spines may also send backwards from the upper border a pair of short spike-like processes, to embrace the neural spine immediately behind it.

In *Serpentarius* the thoracic vertebræ, from the 2nd to the 5th, are pierced by a large pneumatic foramen, opening at the base of the neural spine immediately behind the anterior zygapophysis. This leads into an extensive chamber, excavated out of the vertebral tissue and extending down to the spinal cord, being separated therefrom only by a thin plate of bone. Other pneumatic apertures pierce the lateral walls of the neural tube, and the centrum below this.

In the majority of the Accipitres, the pneumatic apertures of the thoracic vertebræ are restricted to a single opening at the base, and caudad of the transverse process and immediately in front of the base of the postzygapophysis.

In the Cathartæ the apertures are three in number, and lie on

either side of, rather than between, the capitular and tubercular glenoid surfaces.

In the Falconidæ, excepting only *Herpetotheres*, and in Polyboridæ, as already remarked, the thoracic vertebræ 1-4 are ankylosed into a single mass. But this mass also includes the last cervico-thoracic vertebra, so that the whole is made up of five vertebræ. The penultimate thoracic vertebra is free, the ultimate is fused with the synsacrum; so that this free vertebra serves as a hinge in the middle of the back. In some examples of *Polyborus* the antepenultimate vertebra may show traces of its former existence. Such specimens are probably not quite adult.

It is probable that the last two cervico-thoracic vertebræ have not long been transferred to the cervical series, for the dorsal segment of the ribs belonging thereto has as yet undergone no shortening. Those of that vertebra which has ankylosed with the thoracic still retain their uncinate.

In the Falconidæ and Polyboridæ only one, and in other Accipitres two thoracic vertebræ appear to enter into the synsacrum.

The *synsacrum* includes from 12 to 14 vertebræ. In *Serpentarius* it is composed as follows:—2 thoracic, 4 lumbar or cruro-sacral, 2 lumbo-sacral or ischiadic, 2 sacral, and 4 caudal vertebræ.

The anterior renal fossa (fossa ischiadica) in *Serpentarius* is very lofty and narrow; when seen from the ventral aspect, recalling that of *Cariama*. The posterior renal fossa is long and narrow. This last fossa is bounded by a very broad *planum anale*, and this appears to be peculiar to *Serpentarius*, amongst the Falconiformes.

In the Accipitres, the form and size of these fossæ vary much, as is indicated by the following illustrations. It is impossible, however, to do more than indicate the general nature of the form of these fossæ, for they vary in details in almost every species. The anterior renal fossa forms a narrow and lofty chamber, longer than the posterior fossa, in *Busarellus*, *Circæetus*, *Haliaëtus*, *Haliastur*, *Lophaëtus*, *Gypohierax*, and *Antenor*. It is narrow, lofty, and shorter than the posterior fossa in *Parabuteo*, *Aquila*, and *Spizaëtus*. It is wide, lofty, and longer than the posterior fossa in *Falco*, *Chimachima*; wider, lofty, and shorter in *Elanoides* and *Polyborus*. In *Pandion* both these fossæ are exceptionally large, and of the type seen in *Elanoides*. In *Spizaëtus* the posterior renal fossa has reached the minimum limit of reduction, including but a single caudal vertebra.

It will thus be seen that the form of these fossæ is of little or no value for taxonomic purposes other than the identification of species. The lofty and narrow type appears to belong to the more specialized, the wide and shallow to the more primitive members of the respective groups to which they belong.

In *Pandion*, there are three and sometimes four lumbar or cruro-sacral vertebræ, and these are more sharply defined than in the other Accipitres. The lumbar possess well-developed dorso-lateral processes. The sacrals are, in the skeleton, indistinguish-

able from the postsacral (caudal) vertebræ by reason of the long slender ventro-lateral processes of these last, which in no respect differ in appearance from the sacral ribs. Thus the posterior renal fossa (*fossa pudendalis*), which is large, is cut up into a number of separate compartments.

There is a certain resemblance between the synsacra of *Pandion* and *Cathartes*. But the two may readily be distinguished. In *Pandion* the lateral iliac fossa (*fossa lumbaris*) is peculiar on account of the great size of the ventri-lateral processes, the outer ends of which are fused one to another to form a bony bar, upon which the preacetabular ilium rests. The dorsi-lateral processes forming the roof of the anterior and posterior renal fossæ give rise to a large, flat, imperforate plate with convex free borders, showing a distinct suture-line betwixt them and the postacetabular ilia. The intervertebral foramina are almost completely obliterated.

In *Cathartes* the ventri-lateral processes of the lateral iliac fossa are less conspicuously developed. The roof of the anterior and posterior renal fossæ is perforated by large intervertebral foramina; and the lateral edges of the plate forming the roof of this fossa is deeply hollowed both before and behind the sacral vertebræ. There are 6 to 8 postsynsacral vertebræ (free caudals) including the pygostyle. The anterior of these vertebræ bear vestiges of the anterior zygapophyses, which gradually decrease in size from before backwards.

In *Serpentarius* the neural spines are swollen and bifid, the transverse processes are pierced at the base by comparatively large pneumatic apertures. The last 3 or 4 vertebræ bear bifid hypapophyses. The free caudals of *Gypætus* resemble those of *Serpentarius* but are non-pneumatic. In the larger Eagles the transverse processes are much expanded and very wide. The number of caudal vertebræ included in the synsacrum appears to vary between 1 (*Spizaetus*) and 4 (*Serpentarius*). In the Falconidæ the pygostyle bears a pair of accessory plate-like vesicles, attached by their hinder border by ligament to its inferior angle, and projecting forwards as a horizontal plate. Intercentra occur.

#### iv. THE RIBS.

The cervical ribs extend from the third vertebra backwards, and are ankylosed with their respective vertebræ. They are relatively longest in *Serpentarius*. The free, so-called cervico-thoracic belong more correctly to the thoracic series.

The thoracic ribs range from 5 (*Pseudogyps*, *Polyboroides*) to 8 pairs. The 8th pair, however, is never complete: often, as in *Spizaetus* for instance, only the sternal segment is present, fixed by membrane to the 7th pair of sternal ribs. Sometimes the thoracic and sternal segments are widely separated by loss of the intermediate ossified tissue, as in a case of *Aquila chrysaetos*. Whilst in other cases the thoracic and sternal segments are



normally related, yet the latter fails to reach the sternum. In some cases the last pair of sternal ribs may be represented only by vestiges fused with the last fractional pair.

The uncinates vary considerably in their development. In the *Polyborine* and the Falcons the uncinates are long and slender; but in the remaining Accipitres the base of attachment to the rib has increased enormously, extending often nearly as far down as the articulation with the sternal segment. In the Cathartæ, and in some species of *Aquila*, the inferior angle of this base is produced into a short spine. Generally the uncinates do not extend backwards beyond the level of the rib next behind. This is exceeded in *Elanoides*, and in *Pandion* (in *P. carolinensis*) they extend each to the third rib. In *Serpentarius* the uncinates are very degenerate, losing themselves in the rib, forming thereon nothing but a broad irregular plate. The uncinatæ of the first thoracic rib, however, is less degenerate, projecting distinctly backwards.

The preacetabular ilium overlaps from two to three pairs of ribs.

#### V. THE STERNUM AND PECTORAL GIRDLE.

Perhaps the most striking features of the sternum of Falconiformes are the great size of the *corpus sterni* and the relatively slight development of the carina. Amongst the different members of the group, however, much variation occurs, in the relative proportions in the length and breadth of the sternal plate, the development of the keel, the position of the coracoid grooves and articular surfaces for the sternal ribs, and the development of notches or fenestræ on the metasternum.

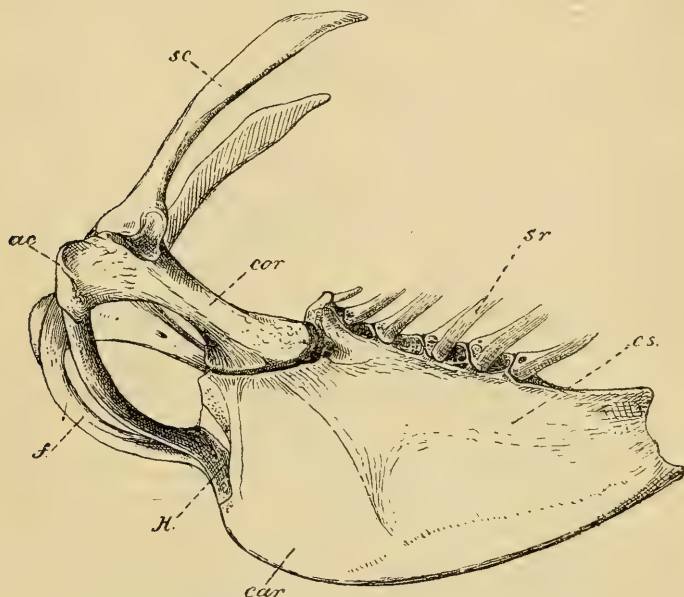
In *Serpentarius* (text-fig. 33, p. 297) the sternum is distinctly Ciconiine in character, not only on account of the great size and shape of the carina, but also in the fact that the latter affords a broad articular surface for the furcula. There is one peculiarity about the keel of *Serpentarius*, however, and this lies in the fact that the carina, swollen by pneumatic tissue, passes gradually into the corpus sterni. This last, it should be mentioned, is pointed posteriorly, instead of notched as in the Storks.

The sternum of the Cathartæ is peculiar in that the greatest curvature of the free margin of the carina is near its middle, and in that the keel extends backwards to the extreme posterior end of the sternal plate. The corpus sterni is notched posteriorly, and in *Cathartes* the posterior lateral processes are fenestrated. The coracoid grooves are shallow and broad, curving abruptly upwards and inwards to the middle line, not overlapping. The spina externa and interna are both wanting. The linea aspera for the origin of the subclavius extends backwards to within a short distance of the posterior end of the sternal plate: thus extending further back than in any other Falconiformes.

In the Falcons only is there a distinct *spina interna*; in *Herpethotheres* it is very broad and deeply hollowed; the *spina externa*

is present in all the Accipitres. In the Falcons only does the anterior angle of the carina project forwards as far as the level of the spina externa. Again, whilst in nearly all the other Accipitres the sternal ribs attach themselves along the whole outer border of the anterior lateral processes, in the Falcons the distal third is ribless. In the larger Falcons the sternal plate is fenestrated posteriorly, but in the small forms—*Melierax*, *Poliohierax*, *Microhierax*—it is notched. In Falcons, the coracoid

Text-fig. 33.



Left lateral aspect of the Sternum and Shoulder-girdle of *Serpentarius serpentarius*, showing the articulation of the furcula with the carina.

ac. = acrocoracoid.

cor. = coracoid.

cs. = corpus sterni.

H. = hypocleidum.

car. = carina.

f. = furcula.

sr. = sternal rib.

grooves overlap one another, and the spina externa is relatively long and pointed. The articular surfaces for the sternal ribs extend backwards as far as the middle of the sternal plate.

The sternum of the *Polyborinae* resembles that of the Falcons, but the *spina interna* is shelf-like instead of spiny, and the anterior border of the keel does not project so far forward.

In the *Buteonidae* (Suschkin) the *spina interna* is not developed. The *spina externa* varies much in size. Generally, it may be described as a short stout tubercle; but in *Accipiter* it becomes a

long spine, as in *Falco*. The sternum varies much both in its relative length and the form of its posterior border. Thus, this last may be either notched or fenestrated, or both, or it may be entire. As these are points which may vary in members of the same genus, they are of comparative little value save as specific characters.

The sternum with the relatively largest carina of this group is that of *Pandion*. The *carina* generally has its anterior border sloped backwards, but in *Accipiter* this border turns forwards and upwards, thus greatly increasing the length of the keel. The carina varies much in its development, generally passing insensibly into a sternal plate before reaching its hinder border, but in *Accipiter* and *Pernis*, for instance, the carina is carried back almost to the extreme free border of the sternal plate.

The sternum of the Accipitres resembles that of the Striges. In many cases this resemblance is rather close. The following characters will be found useful in determining between sterna belonging to these two very different groups. The posterior border of the sternum in the Striges is never entire and never fenestrated, but always notched. With the exception of the sterna belonging to the Strigidae, and the sternum of *Huohua orientalis* of the Bubonidae, there are two pairs of notches. The single pair of notches of *H. orientalis* are of great size. They lie on either side of the metasternum, and extending forwards to beyond the level of the middle of the posterior lateral process, cause the sternum of this bird to closely resemble that of *Microhierax*. The great difference in size, however, renders any possibility of confusion on account of this resemblance impossible. The single pair of notches of the Strigidae resemble those of some Accipitres, e.g. *Elanoides*, in that they are very shallow, so that the posterior lateral processes pass almost insensibly into the metasternum, being divided therefrom only by a sinuous line. But the processes are relatively much longer in the Strigidae than in the Accipitres, and the sternum is narrower. Furthermore, the sternum of the Owls of this group may be distinguished by the fact that the spina externa is obsolete. The *anterior lateral processes* in all the Owls are small. The articular surfaces for the sternal ribs never extend beyond the middle of the sternal plate, rarely so far as this. There is no spina interna.

The *coracoid* presents two forms:—(1) That which obtains in the Falconidae only, wherein there is a distinct hook-like procoracoid process curving downwards till it touches the furcula; and (2) that in which this process is wanting.

In the Falconidae we can distinguish the coracoid of the Falcones from that of the Polybori; inasmuch as in the former there is no trace of the *foramen supracoracoideum* in the dried skeleton, this being bounded internally by membrane only. In the Polybori this foramen is present.

Whether the foramen in the coracoid of the remaining Accipitres is really the *foramen supracoracoideum*, or a foramen pierced

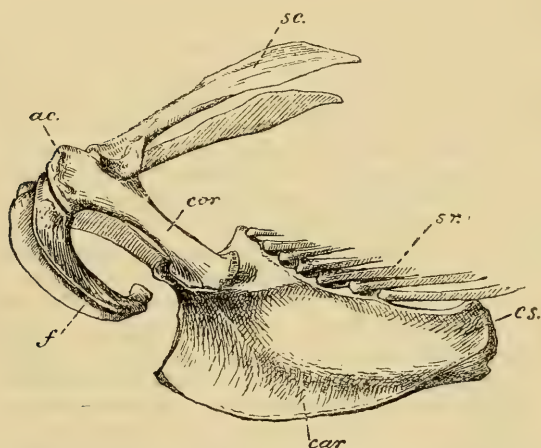
through the coracoid proper, for the passage of this nerve, is a point which can only be determined by an appeal to embryo and nestling specimens. Possibly it will be found that the foramen in the Polybori is also a coracoid foramen.

The coracoid is relatively of medium length in the Falconidæ, but proportionately longer in the little *Microhierax*.

In the Buteonidæ it is relatively short and stout, and very broad at the base, the distance across the latter region, at its widest part, being equal to the length of the shaft from the base to the articulation with the scapula.

In *Elanoides* the *processus lateralis basalis* is very conspicuous, more so than in any other member of the Order.

Text-fig. 34.



Left lateral aspect of the Sternum and Shoulder-girdle of *Aquila rapax*. The furcula does not articulate with the carina; and the latter terminates before reaching the end of the sternal plate.

Letters as in text-fig. 33.

The acrocoracoid process is large in both sections of the Order, and bears a facet for the articulation of the furcula—except only in *Serpentarius*, wherein this facet is wanting. The absence of a procoracoid process is sufficient to distinguish the coracoid of *Serpentarius* from that of the Storks.

The coracoid of the Cathartæ, like that of the Falcons, is relatively long.

The coracoid of the Accipitres closely resembles that of the Striges. In the latter group, however, the procoracoid process is always present; on this account, therefore, the coracoid of the Buteonine section of the Accipitres is always distinguishable. For the same reason—the lack of the procoracoid process—the coracoids of the *Serpentarii* and *Cathartæ* are also easily dis-



tinguishable. With the Falconidæ, however, the case is different; and it becomes a matter of nice discrimination to tell the coracoid of the Falcones, or Polybori, from that of one of the Striges. The Falcones may be distinguished by the absence of a supracoracoid foramen; but in the Polybori and Striges this foramen is present, and almost identical in size and position. The coracoid of the former can, indeed, scarcely be distinguished from that of the latter. In the Owls apparently the base of the coracoid is comparatively deeply grooved to fit the dorsal coracoid lip of the sternum; whilst in the Polybori, what corresponds to the dorsal lip of the groove in the Owls is represented only by a low and incomplete ridge; lastly, in the Owls the linea aspera for the coraco-brachialis posterior generally lies near the extreme lateral border of the coracoid shaft; in the Polybori it lies nearer the middle line.

The *scapula* does not afford much matter for comment of any systematic value. The acromial process in the Falconinæ is pneumatic and very broad, so much so as to project considerably into the *foramen triosseum*, thereby considerably diminishing its size. The acromion may be produced conspicuously forwards, and this is particularly well seen in *Neophron*, where it constitutes the greater part of the inner wall of the *foramen triosseum*.

The *furcula* in the Accipitres is remarkable for its great size and strength. It is U-shaped, with the limbs set wide apart, this latter feature being especially noticeable in the Buteonidæ.

In *Serpentarius* only does the furcula articulate with the *carina* (text-fig. 33, p. 297), as in the Storks. Furthermore, as we have already pointed out, *Serpentarius* agrees with the Storks in that the furcula does not develop a facet for articulation with the coracoid. It bears a hypocleideum of considerable size, directed downwards, and presenting a keel-like border for articulation with the *carina*.

In the Cathartæ only are the distal extremities pierced by a pneumatic foramen. This is very large and opens in the outer aspect of each limb, immediately behind the acrocoracoid.

In the Falconidæ the hypocleideum is vestigial or wanting. In *Microhierax* the furcula is not perceptibly bent upon itself, as in the larger members, nor are the limbs so wide apart. The length of the limbs of the furcula in *Microhierax* is relatively greater than in any other members of the order, since they equal the length of the *carina sterni*.

In the Buteonidæ the limbs of the furcula, as we have already remarked, are set widely apart, and are of great breadth at their distal ends; especially is this the case in such forms as *Gypaëtus*, *Haliaëtus*, and *Aquila*. The hypocleideum is vestigial or wanting. It appears to be largest in *Aquila* and *Pandion*. In some cases, *Elanus* for example, the proximal ends of the furcula are very slender, and in this particular the furcula resembles that of the Striges. The furcula of the Accipitres is more unlike that of the Striges than is the case with the sternum or coracoid, as

we have already shown. With the exception of *Serpentarius*, the furcula never articulates with the carina in Falconiformes. In the Striges, on the contrary, the furcula is always attached to the carina. Furthermore it is a much more slender bone than in the Falconiformes, and not bent upon itself.

#### vi. THE PELVIC GIRDLE.

The pelvic girdle of the Falconiformes, through the more aberrant members of the group, bears resemblances on the one hand to that of the Gruidæ, and on the other to that of the Ciconiidae; and, through the more specialized forms, to the Striges. The innominates are never free.

*Serpentarius* presents several Gruine characters, the most noticeable of which are the pocket-like cavities (iliac recesses) of the postacetabular ilium, and the general contour of the dorsal aspect of the pelvis as a whole.

The pelvis of *Serpentarius* is, however, distinguishable from the similar Gruine and Ciconiine pelves by the great height of the supra-trochanteric process, and the enormous size of the ilioischadic foramen. Furthermore, the ischium terminates posteriorly in a rounded or rather conical border projecting beyond the postacetabular ilium; whilst the pubis, which is long and slender, sends up a conical process immediately below the projecting extremity of the ischium, which serves more or less effectually to close the obturator fissure posteriorly.

The preacetabular ilia meet one another in the mid-dorsal line, and there is no trace of the suture between the postacetabular ilium and the transverse processes of the synsacrum. The synsacral fossæ lying between the neural spines and the postacetabular ilium are roofed over by a thin plate of bone. The obturator fissure is not separated from the foramen.

The pectineal process is wanting, not only in *Serpentarius* but in all the pelves herein described.

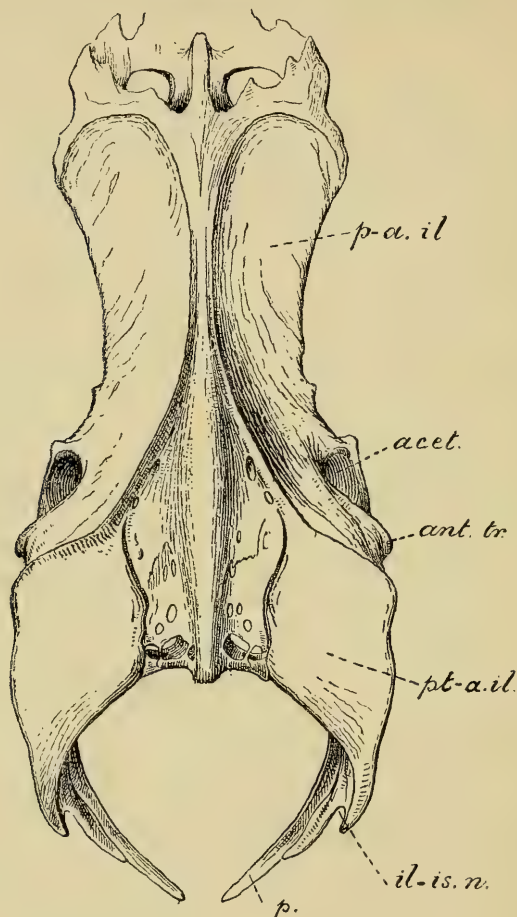
In the Cathartæ the pelvic girdle is, externally, distinctly Ciconiine in character. The resemblances are especially noticeable in the pelves of *Pseudogryphus* (text-fig. 35, p. 302), *Catharistes* (text-fig. 36, p. 303), and *Gypagus*.

The presence of iliac pockets, however, at once distinguishes these pelves from those of the Ciconiæ. Another Stork-like feature is the deep notch in the hinder border of the innominate, marking the division between the now-fused ilium and ischium. In *Sarcorhamphus*, *Pseudogryphus* (text-fig. 35, p. 302), and *Gypagus* the inferior limb of this notch is produced backwards for a very considerable distance beyond the postacetabular ilium to form a long spine. In the degree of development, and in the position of the supra-trochanteric process, the innominate of the Cathartæ is Gruine.

The pelvis of *Cathartes* differs markedly from that of the other genera in this: That whilst in the genera just discussed the

preacetabular ilia rise above the synsacrum to meet one another in the middle line; in *Cathartes* they are widely separated one

Text-fig. 35.



Dorsal aspect of the Pelvis of *Pseudogryphus californianus*, showing the Ciconiine character of the pelvic girdle. The preacetabular ilia rise above the ridge formed by the neural arches of the vertebræ, and the external intertransverse sacral foramina are almost completely filled up.

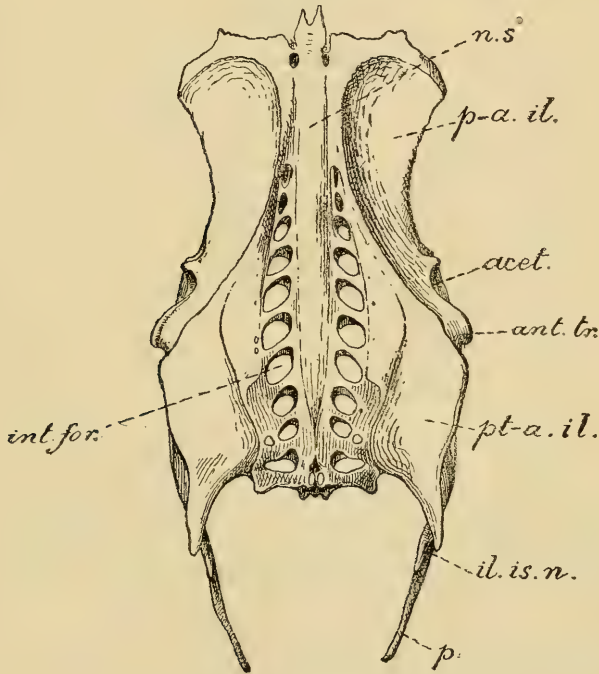
*acet.* = acetabulum.  
*ant.tr.* = antitrochanter.  
*il-is.n.* = ilio-ischiadic notch.

*p.* = pubis.  
*p-a.il.* = preacetabular ilium.  
*pt-a.il.* = postacetabular ilium.

from another, and do not rise above the synsacrum. The peculiar form of this pelvis bears a striking resemblance to that of

certain Steganopodes. The resemblance is perplexing, and would seem to suggest that it is from this more primitive stock that the Falconiformes, in common with the Ciconiæ, have been derived: the Ciconiine characters of the Falconiform skeleton, already alluded to, being homoplastic. On the whole, however, I feel, at present, inclined to adopt the Gruine origin of the Falconiformes, suggested by Beddard. *Cathartes* and *Catharistes* agree in that the backwardly produced spine of the ischium does not project far beyond the postacetabular ilium. The iliac pockets of the *Cathartæ* are conspicuous by their absence.

Text-fig. 36.

Dorsal aspect of the Pelvis of *Cathartes aura*.

This is probably a more primitive type of pelvis than that of *Pseudogryphus*, and recalls that of *Fregata* or *Phaethon*. Note that the preacetabular ilia are widely separated, lying on either side of the broad ridge formed by the vertebral neural spines, and that the intertransverse sacral foramina are large and numerous.

*Additional letters.*

*int. for.* = intertransverse sacral foramina.

*n.s.* = neural spines.

We now turn to the pelvic girdle of the Accipitres. Here



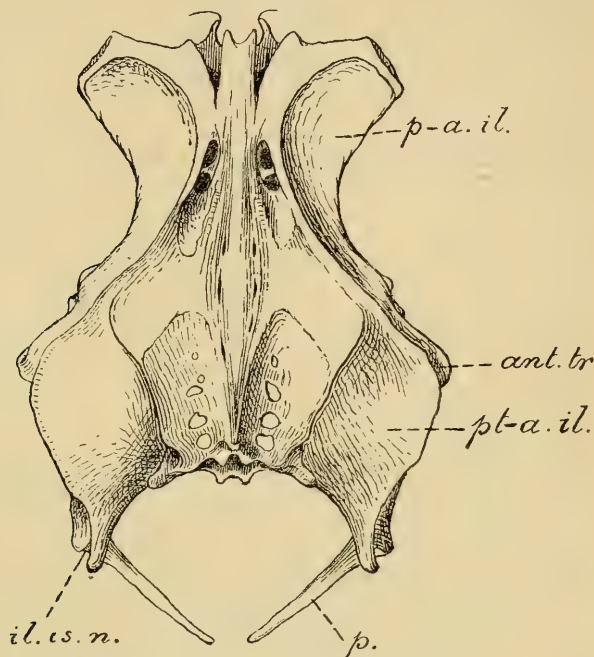
we meet with a type of pelvis found elsewhere only amongst the Striges. Its chief characteristic is the great deflection and shortening which the postacetabular ilium has undergone, and this is more marked in the Accipitrine innominate. The innominate bone of the Owls can, however, it would seem, be readily distinguished by the fact that the ischium is invariably produced backwards into a more or less slender spine resting on the pubis.

In its general conformation the pelvic girdle of the Falconiformes, after the elimination of the Gypogeranidæ and Cathartæ, is very uniform: modifications from the type are very considerable. Some of the more noticeable, however, may profitably be commented upon here. The most conspicuous departure from the type is found in the pelvis of *Pandion* (text-fig. 37, p. 305), which is remarkably broad. This great breadth is due partly to the length of the outstanding transverse processes of the synsacrum, which support the roof of the anterior and posterior renal fossæ; and partly to the exceptionally broad dorsal plane of the postacetabular ilium. The preacetabular ilium is sharply truncated anteriorly, and is widely separated from its fellow of the opposite side: so much so that a tubular aperture—the *canalis ileo-lumbalis*—is left at the point where the mesial curved border leaves the synsacrum. The glenoid surface of the antitrochanter is oblong in shape and curved backwards. The ilio-ischiadic foramen is of great size. The obturator foramen is also very large, and closed posteriorly by the approximation of the pubis to the inferior border of the ischium, which, we may remark, turns abruptly upwards at its hinder end. The pubis is long, and develops a crescentic plate the cephalad segment of which fits closely to the upturned ischial border; beyond this it is continued backwards for a considerable distance as a rod-shaped bar nearly meeting its fellow of the opposite side.

The pelvis of *Pandion* (text-fig. 37, p. 305) is an exaggeration of the typical Accipitrine pelvic girdle, which may be very well represented by such a form as is presented in *Polyborus* for example. Herein the pre- and postacetabular ilia are about equal in length. The former is a moderately broad concavo-convex plate directed outwards and downwards, meeting its fellow of the opposite side in the middle line, and having its superior border accentuated by a sharply-defined outstanding crest, which, in some forms, as in *Haliaëtus* and *Parabuteo* for example, becomes still more strongly accentuated, forming an almost shelf-like projection. This border is continued backwards to terminate in an overhanging supra-trochanteric process. The postacetabular ilium expands into broad dorsal plates, terminating somewhat abruptly some distance from the end of the ischium, with which it is fused. In *Accipiter* and *Elanus*, and still more markedly in *Polyboroides*, the dorsal border of the ischium turns sharply inwards so that the dorsal plate of the ilium forms a relatively enormous ledge overhanging a deep cavern passing forwards into the obturator foramen. In

*Aquila*, *Thrasaëtus*, *Haliaëtus*, *Circaëtus*, for example, the post-ilia pass insensibly backward into the ischium, instead of abruptly.

Text-fig. 37.



Dorsal aspect of the Pelvis of *Pandion haliaëtus*.

As in the pelvis of *Cathartes*, the præacetabular ilia fail to rise above the neural spines of the vertebræ. A pair of canales ileo-lumbales are present, but most of the intertransverse sacral foramina have become filled up. The great breadth of the pelvis, as shown in text-fig. 36, p. 303, is caused by the unusual length of the sacral ribs and transverse processes.

In the majority of Accipitres the pre- is longer, sometimes nearly twice as long, than the postacetabular ilium, which is markedly deflected.

The *ischium* is generally truncated posteriorly, but in some, as in *Thrasaëtus* and *Aquila* for example, the posterior end is hastate.

The *pubis* is generally long and slender, and at the level of the end of the ischium turns abruptly inwards towards the middle line nearly meeting its fellow of the opposite side. In *Thrasaëtus*, *Lophaëtus*, *Parabuteo*, it is vestigial, only the proximal end remaining. This terminates immediately behind the obturator foramen, and serves to close it, often by fusion with the

ischium. In many forms, as in some species of *Falco*, *Herpethotes*, *Elanoides*, *Elanus*, *Spilornis*, *Accipiter*, the median portion of the pubis has disappeared, the proximal portion fusing with the ischium, immediately behind the obturator foramen, whilst the distal (hinder) ends are attached to the posterior border of the ischium. Thus several grades in the degeneration of this bone are presented. Sometimes the two portions are connected by a very slender thread of bone.

The iliac recess in *Serpentarius* is spacious, and extends backwards into a pocket-shaped cavity, as in Rails. This pocket is wanting, or but feebly developed, in the other Falconiformes, except *Pandion*, but it is interesting to note that it is universally present in the Striges.

#### vii. THE PECTORAL LIMB.

Not only is there little variation in the form of the wing between the different members which are included in the present group; but there is also a strong resemblance between the wing of the Falconiformes and that of the Grues on the one hand, and the Storks on the other: the resemblance to the Grues being especially marked.

The following characters displayed by the *humerus* will help in distinguishing between the wings of these three groups:—In the Falconiformes and Grues the scar marking the insertion of the pectoral muscle runs along the free border of the triangular pectoral crest from the *tuberculum externus* till it reaches the summit of the triangle, where it expands into a broad elliptical space occupying the lower limb, and, in the Cathartæ, extending on to the shaft. In the Ciconiæ the distal extremity of this scar takes the form of a strongly-raised, linguiform plate which lies partly on the shaft of the humerus and partly at the base of the distal limb of the crest; instead of occupying nearly the whole crest. The humerus of the Falconiformes may be distinguished from that of the Grues in that, in the former, the subtrochanteric fossa is larger, the distal extremity of the humerus is much wider, and its ulnar tuberosity much more prominent.

The coraco-humeral groove appears to be markedly developed only in *Pandion*. In other forms it is either indicated only by a very shallow groove, or by two depressions. The head of the humerus in the Falconiformes is more compressed from palmar to dorsal surface than in the Grues. The supra-condylar depression for the brachialis inferior varies in its development. In *Pandion*, for example, it is deep with gently sloping sides; in *Gypagus* the floor is flat and oval and is bordered by a well-defined rim imperfect distally: in *Falco* and *Accipiter* again it is barely traceable; in *Serpentarius* it is an oval depression placed rather high up in the shaft. A small tubercle only, represents the ectepicondylar process. The form of the pectoral crest varies. In *Serpentarius*, *Pandion*, and Falcons it is sharply triangular, and in *Pandion*



the proximal border of this triangle is deeply hollowed. In *Accipiter* the distal border terminates abruptly. The pectoral crest is very long, extends far down the shaft, and is semicircular rather than triangular.

The relative proportions of the arm, forearm, and manus vary. Generally the manus is the shortest segment, and the forearm the longest. In *Falconinae* and *Elanus*, for example, the manus is the longest and the humerus the shortest. But the forearm is always longer than the humerus.

The *forearm*, as a rule, shows only faint traces of tubercles marking the attachment of the quill-feathers. In *Cathartæ*, however, these tubercles are very strongly developed, thus recalling the ulna of the *Ciconiæ*. The *radius* of the Falconiformes is more nearly cylindrical than in the *Grues*.

The *manus*, as we have already remarked, may be longer than the humerus, it never exceeds the forearm. The third metacarpal is slender, laterally compressed, and, save in *Serpentarius*, is attached only by its extreme proximal and distal ends. The manus may on this account be more or less readily distinguished from that of the *Ciconiæ* or the *Grues*. In the members of both these groups the proximal end fuses with the second metacarpal distad of a line drawn transversely through the metacarpus at the level of the articulation for the pollex. The distal end of metacarpal III. in the Falconiformes, *Serpentarius* excepted, resembles that of the *Ciconiæ*, and differs, like the latter, from that of the *Gruidæ* and *Serpentarius*, wherein the inter-metacarpal space is lessened by the deposition of bony tissue. It is extremely difficult to distinguish the manus of the smaller *Accipitres* from that of the *Striges* of similar size. Perhaps the only character which will hold good for a large series of comparisons is that afforded by the point of fusion of the proximal end of metacarpal III. In the *Owls* this takes place distad of a line drawn through the metacarpus at the articulation for the pollex, as in the *Ciconiæ* and *Grues*.

The phalanges do not call for any special comment. The pollex bears a small claw. The postaxial border of the only phalanx of digit III. has the middle of the postaxial border raised into a small tubercle.

#### viii. THE PELVIC LIMB.

The pelvic limb in all the Falconiformes, save *Serpentarius*, is shorter than the pectoral. But whilst, as in *Polyboroides*, the two limbs are nearly equal in length, in *Serpentarius* the difference is very considerable.

The femur, in all, is pneumatic, a pneumatic foramen opening on the dorsal aspect of the femur, mesiad of the base of the great trochanter—as in the *Ciconiæ*. The popliteal fossa is but feebly developed. The shaft is moderately long, and cylindrical.

The *tibio-tarsus* is in all more or less dorso-ventrally depressed,



and is slightly bowed forwards. The cnemial crests are not largely developed.

In *Serpentarius* they form prominent outstanding blades, not extending down the shaft but strictly confined to its proximal extremity. The ectocnemial crest is directed outwards, standing at right angles to the entocnemial. In so far as the direction of this crest is concerned, it agrees with the remaining Falconiformes, but in its greater size it stands alone. Furthermore, the shaft of the tibio-tarsus is peculiar, in that it is perfectly straight and almost cylindrical, not bowed forwards and depressed as in the other Falconiformes. The tibio-tarsus thus much more closely resembles that of the Storks. Additional Stork-like characters are found at the distal end of the shaft in the great breadth of the extensor bridge, and in that the lateral borders of the posterior trochlear surface are produced backwards and upwards into a pair of prominent ridges. But there is no intercondylar tubercle, and no depression below the extensor bridge. The trochleæ are not laterally compressed, but separated by a wide and deep gorge. There is a conspicuous entocondylar tubercle. The fibular crest is but feebly developed, but the fibula extends down to the lower third of the shaft.

The tibio-tarsus of the Cathartæ is much more Accipitrine in character. The fibular crest is prominent. The extensor bridge is wide, oblique, placed nearer the inner border of the shaft, and somewhat more superficial than in the other Falconiformes.

In the Falconidæ and Buteonidæ there is not much difference, save in minor points, some of which, however, are extremely helpful for diagnostic purposes.

Take the Falconidæ for example. In *Herpetotheres*, immediately above the outer tibial condyle, and laterad of the extensor bridge, is a shallow pit. This, in *Polyborus*, becomes pierced by a small foramen opening inwards into the extensor groove. In the remaining Falcons (*Herpetotheres* being the exception) and in *Milvago* this small foramen has increased to an aperture as large as that below the extensor bridge. Thus there appears to be two extensor bridges, one above each condyle. Apart from size, the tibio-tarsus of *Herpetotheres* can easily be distinguished from that of *Polyborus* by the fact that in the latter the bridge is wider and the intercondylar gorge is narrower and deeper.

In the Buteonidæ the most aberrant tibio-tarsus is that of *Pandion*. One of its most striking characters is the extreme depth and width of the extensor groove, which is so deep that it is saved from perforating the shaft only by a very delicate plate of bone. The fibula extends to within a short distance of the tarsal segment, and is very large. The fibular ridge is placed somewhat lower down the shaft than usual. The distal end of the shaft, above the extensor bridge, is wider than across the condyles, which are laterally compressed.

It is a point of considerable interest to notice that the extensor groove in the Striges is barely perceptible in the Barn-Owls,

deep in the remaining forms, whilst the ossified extensor bridge is conspicuous by its absence. The absence of this bridge should surely be as valuable a piece of evidence that *Pandion* is not related to the Striges, as is the presence of an extensor bridge on the tarso-metatarsus to show that it is so related! Furthermore, we may remark that this tarso-metatarsal bridge is wanting in the Barn-Owls, so that the value of this character is still further weakened.

The tibio-tarsus of *Polyboroides* is, in its way, almost as remarkable as that of *Pandion*. It is long and almost of the same thickness throughout. As in *Pandion*, the width of the shaft immediately above the distal condyles is greater than across the condyles themselves. This is probably due to the fusion with the shaft of the distal end of the fibula which extends down to the tarsal elements—though, as just indicated, fused with the shaft. The extensor bridge is placed transversely across the shaft. The tibial condyles are but feebly developed, the ectocondyle barely projecting beyond the shaft. The intercondylar gorge is wide.

The lower third of the shaft of the larger Accipitres is dorso-ventrally depressed. There is often an additional and well-defined fibular bridge. The second lies some distance below the first, and affords attachment for the distal end of the fibula. The cnemial crests are relatively but slightly developed. In *Aquila*, perhaps, they reach the maximum development, the entocnemial crest being unusually strong. In *Thrasaëtus* the ecto- and entocnemial condyles are conspicuously wide apart, causing the inner border of the shaft to have a very marked curve.

The *fibula*, as a rule, tapers to a fine point, and terminates near the lower third of the tibial shaft, sometimes fusing therewith. In *Pandion*, *Polyboroides*, and *Pernis* only is it of almost uniform thickness and continued downwards as far as the tarsal elements.

The *tarso-metatarsus* varies extremely, both in its relative length and in the development of bony matter for the mechanical requirements of the limb.

In *Serpentarius* only is the tarso-metatarsus as long as the tibial shaft. In *Accipiter*, however, it is very nearly so. Generally it is shorter than the femur.

The hypotarsus is simple in all save *Pandion* and *Pernis*, wherein it forms a tube.

The distal trochleæ, save in *Serpentarius* and *Cathartæ* and in *Leptodon*, are all on the same level. In the two first-mentioned exceptions the middle trochlea is produced somewhat beyond the level of the others. In *Leptodon* the inner trochlea is the longest, the middle slightly shorter, and the outer shorter still, so that an obliquely sloping series is formed. The plane of the trochleæ forms a slight and regular curve, except in *Pandion*, in which this curve is very strong; and *Polyboroides*, in which the 2nd and 3rd trochleæ lie close together, whilst the 1st is bent downwards so


that the dorsum of the trochlea lies almost behind the level of the 2nd and 3rd. The regularity of the curve is thus broken.

Usually the outer and inner trochleæ are produced backwards into spur-like processes, that of the outer trochlea being directed backwards, whilst the inner slopes obliquely outwards and backwards away from the shaft. In some few cases, as in *Leptodon* for example, these spurs are barely perceptible.

In *Serpentarius*, the Cathartæ, and the Falconidæ the hypotarsus takes the form of a strong median keel. But whereas in the two former the keel is grooved equally on either side, and terminates above in a more or less quadrangular table; in the latter it is much more deeply grooved externally, and terminates above as a thin vertical plate with a flanged free border. The front of the tarso-metatarsus in *Serpentarius* and Cathartæ is deeply grooved. In the former are two distinct raised surfaces for the tibialis anticus, in the latter only one. Immediately above the surface for attachment of the tibialis anticus are two foramina, large in the Cathartæ, small in *Serpentarius*.

In the Falconidæ the anterior tarso-metatarsal groove is shallow, the foramina are small, and there is but a single raised process for the tibialis anticus, which lies on the inner side of the shaft.

In the other Accipitres the hypotarsus takes the form of two more or less prominent spurs separated by a wide groove. The inner spur is generally somewhere near the middle line of the shaft, but in *Elanus* it springs from the inner border of the shaft.

The shaft of the tarso-metatarsus is very variable in form. In *Serpentarius* it is long and cylindrical, but with the inner aspect grooved, but in the majority of the Accipitres it is more or less dorso-ventrally flattened and twisted into long and broad ledges and plates; thus adding exceedingly to its power. These features are most marked in *Thrasaëtus*, which in section is seen to be almost -shaped. The same is true of *Aquila*, *Haliaëtus*, *Parabuteo*, *Busarellus*, *Antenor*, *Urubitinga*, and *Helotarsus*, for example, but to a lesser extent. In forms such as *Gypohierax* and *Gypaëtus* the shaft is much less markedly modified, and this accords well with their habits. *Polyboroides* has a peculiar shaft. This, as we have previously remarked, is long, much flattened antero-posteriorly, and deeply grooved behind: its outer border is flattened out into a relatively broad plate, so that in section the shaft resembles that of *Thrasaëtus* without the lateral torsion.

The phalanges are also characteristic. In *Serpentarius* the ungual phalanges are large but not remarkably so. Ph. 1, 2 of digit II. are subequal; ph. 2, 3, digit III. are shorter than ph. 1; ph. 3 and 4, dig. IV. are much reduced.

In Cathartæ ph. 1 of the hallux is very long; the phalanges of digits II., III. are also relatively much longer than in *Serpentarius* or the Accipitres. The phalanges 2, 3 of dig. IV. are also longer, relatively, than in other Falconiformes.

In the Falconidæ ph. 1 of dig. II. is considerably shorter than

ph. 2, but not so much as in the other *Buteoninae*. Similarly ph. 2 of dig. III. and ph. 2, 3 of dig. IV. are relatively much longer than in the latter group.

In the *Buteonidæ* ph. 1 of dig. II. is very short and often fused with ph. 2, as in *Haliaëtus* for example: ph. 2, dig. III. is generally much shorter than ph. 1 and 3: ph. 3, 4, dig. IV. are always very short. In *Elanus* ph. 3 is reduced to a vestigial condition.

In *Accipiter* ph. 2, dig. III. is not shortened: in *Elanus* it is exceedingly so. Again, in *Accipiter* ph. 2, 3, dig. IV., though obviously shortened, are not nearly so much so as is usually the case among the *Accipitres*. The numerous variations of this character are useful generic characters, and will be found in the keys which it is proposed to add to this paper.

It is interesting to note that the foot of the *Striges* in the matter of proportionate lengths of the phalanges resembles the *Buteonine* section of the *Accipitres*.

#### ix. SUMMARY.

Adaptation to a raptorial mode of life has so profoundly modified the skeleton of the *Falconiformes* that much of the evidence concerning the origin of the group has been defaced or obscured.

The most aberrant members of the group are the *Cathartæ*. So markedly do these differ from the other *Accipitrine* forms that authorities of no less weight than Garrod and Forbes, for instance, regarded them as an Order apart therefrom. Thus Garrod placed them with the *Ciconiæ* and *Steganopodes*, and Forbes with the *Ciconiæ* and *Tubinares*. This was based on a study of the anatomy of the soft parts—plantar tendons, thigh- and wing-muscles, and trachea, and on the vestigial condition of the cæca, and in all these particulars the group is undoubtedly *Stork-like*.

Mr. Beddard, however, has recently<sup>1</sup> expressed his belief in the derivation of the *Falconiformes* from a *Gruine* stem, and has furthermore brought forward some convincing evidence in support of his views. The *Stork-like* characters of the *Falconiformes* are possibly to be traced from their origin low down on the *Gruine* stem before the characters common to the diverging branches of *Storks* and *Cranes* began to undergo transformation.

Osteologically, the *Falconiformes* are certainly more *Gruine* than *Ciconiine*, and here the character most to be depended upon is found in the skull. It is a comparatively small point, at first sight, yet it explains the apparently wide differences which separate the skull of the *Cathartæ*, not only from that of all the other *Falconiformes*, but from that of all other members of the Class *Aves*.

The *Cathartæ*, it will be remembered, have a desmognathous palate of a quite peculiar type, the maxillo-palatine processes

<sup>1</sup> Structure and Classification of Birds. 1898.



being much reduced and widely separated, but, nevertheless, bridging the palate; and this by means of a pair of strap-shaped processes, arising from their inner dorsal borders, and extending mesially to meet a horizontally expanded plate developed by the inferior border of the ossified hinder end of the nasal septum. These processes—the anterior septo-maxillary spurs of Parker—feebly developed in *Rhinochætus* and *Tetrapteryx*, are well seen in *Psophia* (Pl. XXXIII. fig. 8); and Mr. Beddard was, I believe, the first to point out their homologies and the part they play in the formation of the peculiar palate of the Cathartæ. Thus, in describing the palate of *Psophia* he says, "If these processes were to be increased in size and to meet a bony internasal septum, we should have the 'desmognathous' skull of the American Vultures." It is possible, that at the time Mr. Beddard did not quite grasp how nearly the Psophiine skull approached the realization of the modifications peculiar to the Cathartæ, since I gather—from his silence on the point—that there was no trace of an ossified nasal septum in the skull or skulls which he examined. In all the skeletons at the Natural History Museum, save one, there is no septum, which has apparently been lost in maceration. In this one, it takes the form of a greatly fenestrated plate tapering forwards to a point, and terminating at the distal fourth of the external nares. The fenestration in this species is so extensive that only the hinder end and dorsal border are left, but the hinder end dips downwards so as nearly to touch the maxillo-palatine processes. If this septum developed a horizontal plate, as in the Cathartæ, we should have the same type of desmognathism which is now peculiar to the last-named group.

The nasal septum of the Cathartæ is more reduced anteriorly than in *Psophia*, never extending forwards beyond the posterior third of the external narial aperture (in the skeleton), and in some genera is not even visible on a side view of the skull. In *Pseudogryphus* and *Catharistes* it may be studied to best advantage. In the former it extends nearly as far as the middle of the narial aperture, and is fenestrated much as in *Psophia*. The bony tissue which in *Pseudogryphus* forms the anterior border of the fenestra is wanting in *Catharistes*, so that the septum is invisible when the skull is seen from the side, but, when viewed from below, the sutures between the horizontal plate of the nasal septum and the septo-maxillary spurs are plainly visible.

Mr. Beddard, in pointing out the nature of the Cathartine palate, and the probable source from which it was derived, has given us the key to a very important problem—the origin of the Falconiform stem. The Cathartæ are the least specialized members of the group, and, it is interesting to note, are also New World forms like *Psophia*. But the low generalized position of the Cathartæ is shown as well by other portions of the skeleton as by the skull. We may, I think, safely regard the Cathartæ as the most primitive of the Falconiformes.

The importance of a correct understanding of the evolution of

the Falconiform palate must be our justification for pursuing this matter a little further.

The palate of the Cathartæ is undoubtedly of an extremely specialized type, but traces of a like modification are not wanting in a direction where hitherto they have not been looked for—to wit, in the Accipitres proper.

The palate of *Elanus*, as we have already described, is schizognathous, a fact first pointed out by Shufeldt; but the schizognathism is of a specialized character, being due to the extreme reduction of the maxillo-palatine processes. If the nasal septum in the skull of *Elanus* be examined, it will first of all be remarked that it is more complete than in the Cathartæ, and next that, near its posterior inferior angle, it gives off a pair of small horizontal processes, resembling those of Cathartæ, but relatively smaller; these almost touch the maxillo-palatines. A little increase in the size of these spurs, and the reduction of the anterior portion of the septum would give us the Cathartine palate. Thus, then, the palate of *Elanus* must be held to represent the high-water mark of specialization in the direction of schizognathism in the Accipitres.

It is probable that the palate of *Circæetus*—or rather the maxillo-palatines—represents the intermediate type from which the extremes of schizog- and desmognathism in the group have been derived. Furthermore, it may profitably be compared with the palæognathine maxillo-palatine of, say, the Tinamous. It must be remembered that the great feature of the palæognathine palate is the enormous size of the maxillo-palatines. In the highly specialized *Tinamus* this is much reduced, and in general shape is not unlike that of *Circæetus*, but lacks its vertical plate of spongy tissue. It is important that the intermediate character of the palate of *Circæetus* should be recognized, otherwise we commit ourselves to the admission that the desmognathous palate of forms like the Falconidæ or *Aquila*, for example, were developed by the resuscitation of an almost defunct organ. In *Circæetus*, then, the maxillo-palatines are represented by a pair of vertical plates of spongy tissue nearly meeting in the mid-ventral line. They run backwards nearly as far as the antorbital plate (prefrontal); and forwards, then inwards towards the tomium, so as to leave a palatal vacuity exposing the nasal septum as in *Elanus*. Reduction of this type of maxillo-palatine gives us the highly specialized type of *Elanus*, its further increase the type seen in the Falconidæ, notably through *Milvago* to *Polyborus* and *Ibycter* (Pl. XXXIII. figs. 3, 5), wherein the maxillo-palatines have attained a relatively enormous size. In the Falconinæ we meet with an exactly parallel series, passing through *Harpa* to *Herpetotheres* (Pl. XXXIII. figs. 2-4). In the higher Falcons an increase in size of the anterior nasal chamber, eventually, in *Falco*, developing into a much inflated ossified bulla, has brought about a considerable reduction in the size of the maxillo-palatine processes; the fenestrated bullæ, seen in such perfection in

*Herpetotheres*, are now reduced to quite vestigial proportions, the various stages in this reduction being readily traceable through *Cerchneis* and *Hierofalco* (Pl. XXXIII. fig. 1) to *Falco*.

For further evidence, or rather clues, as to the origin of the Falconiformes—from an osteological standpoint—one would turn naturally, to the Serpentariidæ. In so far as the skull is concerned, this would prove disappointing. In its general character it certainly resembles that of *Cariama*, but in details it is thoroughly Accipitrine. The ventral view of the palate resembles that of *Aquila*; whilst in the form of the maxillo-palatine processes, especially with regard to the great size of the antrum of Highmore, it approaches *Leucopternis*, *Antenor*, and *Parabuteo*. The palate is indirectly desmognathous. The maxillo-palatines are separated only by a mere chink, and the desmognathism is effected by the ossified nasal septum, fusing with the dorsal aspect of the maxillo-palatines. In the presence of functional basipterygoid processes it differs from all the Falconiformes save the Cathartidæ. In the trunk skeleton we have already pointed out many Ciconiine characters, which are not difficult to account for if, as Beddard and others hold, the Ciconiidæ and Gruidæ may claim a community of descent.

It is certain that the evidence of the skeleton, supported by the facts which have come to light concerning the myology and other soft parts, demands that the Cathartidæ and Serpentariidæ must be included with the Falconiformes, though representing, each, a distinct sub-order. With the Striges the reverse is the case. Strikingly similar as is the skeleton of the Owls, in many characters, to that of the Accipitres, it is nevertheless certain that the nearest allies of this group must be sought among the "Picarian" birds. On osteological evidence alone, however, it is doubtful whether the Striges would ever have been separated from the Accipitres. The anatomy of the soft parts, however, seems to prove conclusively the justice of this separation. The osteological resemblances must be regarded as homoplastic—or, as some would have it, probably, kinetogenetic.

The relation which the Cathartidæ, Serpentariidæ, and Striges, severally, bear one to another and to the Accipitres proper, having now been briefly summarized, we may pass on to the discussion of the inter-relationships of the last-mentioned group.

This exceedingly difficult problem has lately been attacked by Dr. Suschkin. The main results of his study have already appeared<sup>1 2 3</sup>, and, from what he has foreshadowed, it is not too much to say that his complete Monograph will prove one of the most valuable and complete contributions to the osteology of Birds ever published.

<sup>1</sup> "Beiträge zur Classification des Tagraubvögel mit zugrundelegung des osteologischen Merkmale." Zool. Anzeig. xxii. 1899.

<sup>2</sup> "Systematische Ergebnisse osteologisches Untersuchungen einiger Tagraubvögel." Zool. Anzeig. Bd. xxiii. 1900.

<sup>3</sup> "Weitere systematische Ergebnisse vergleichendosteologisches Untersuchungen der Tagraubvögel." Zool. Anzeig. Bd. xxiii. 1900.

My study of this group has convinced me of the soundness of Dr. Suschkin's conclusions, as published in the papers to which I have just referred. But whilst his investigations have extended over a period of about five years, mine have been limited to a few months. For this reason I withhold for the present the keys to the genera, such as have been included in my former papers. I hope to complete these at a later date.

Before the publication of Dr. Suschkin's papers I had already arrived at the same conclusions as are therein expressed with regard to the position of the Falcones and Polybori, and of *Gypaëtus* and *Gypohierax*. With regard to *Pandion*, though I felt certain it had nothing to do with the Striges, I had not yet discovered any further clue as to its real affinities.

What follows is practically an embodiment of Dr. Suschkin's views *in toto*: where I have had to interpret him, that is to say where I have endeavoured to express what I believe to have been his views, I hope I have done him justice.

The sub-order, then, of the Accipitres is divided into two Families, the Falconidæ and the Buteonidæ.

The family Falconidæ is to be divided into two sub-families: (1) the *Falconinæ*, (2) the *Polyborinæ*.

The former includes the genera *Harpa*, *Herpetotheres*, *Micrastur*, *Microhierax*, *Poliohierax*, *Tinnunculus*, *Hypotriorchis*, *Hierofalco*, and *Falco*.

The sub-family Polyborinæ embraces the genera *Milvago*, *Senex*, *Phalcobænus*, and *Polyborus*.

The family Buteonidæ is divided into some eleven or twelve sub-families, though on this point I am not quite clear, as Suschkin has not definitely expressed himself on this point. But he would apparently recognize the following: *Elaninæ*, *Perninæ*, *Milvinæ*, *Aquilinæ*, *Thrasætinæ*, *Vulturinæ*, *Circætinæ*, *Polyborinæ*, *Circinæ*, *Urubitinginæ*, *Buteoninæ*, and *Accipitrinæ*.

In the *Elaninæ* are included *Elanus* and *Machæramphus*. In the *Perninæ*, *Pernis*, *Baza*, *Elanoides*, *Leptodon*, and *Pandion*. But from views he expressed in conversation, he would, I suspect, probably make a separate sub-family for *Pandion*—*Pandioninæ*; and most, I think, will feel this advisable.

The *Milvinæ* include *Milvus*, *Haliastur*, and *Haliaëtus*, with, apparently, *Ictinia*, *Rostrhamus*, and *Polioaëtus*. *Haliaëtus*, there can be little doubt, has nothing to do with the Eagles. *Polioaëtus* Suschkin shows to be undeniably distinct from *Pandion*. The plantar tendons, as he proved, by a dissection made in this Museum, are of the Accipitrine type: the skeleton in no way resembles that of *Pandion*; on the contrary, the pelvis and breast-bone, so characteristic in *Pandion*, bear a quite extraordinary resemblance to those of *Haliaëtus*. The outer toe is not more reversible than in ordinary Accipitres. *Haliaëtus*, *Thalassæëtus*, and *Polioaëtus* might well be made to form a separate sub-family, *Haliaëtinæ*.

The sub-family *Aquilinæ* includes *Aquila*, *Uroaëtus*, *Spizaëtus*, *Nisaëtus*, and *Lophoaëtus*. The *Thrasætinæ* contain *Morphnus* and *Thrasaëtus*.



This brings us to the Vulturinae. By most, this sub-family is regarded as of more importance than is allowed in the present scheme: Gadow and Sharpe, for example, according to the rank of a family. That the Vultures have undergone a considerable amount of specialization there can be no doubt; but it seems equally certain that they are not far removed from the *Circætinæ*. Suschkin recognizes evidence of two distinct branches in this family—*Gypohierax* standing at the base of one, and leading to *Neophron* and *Gyps*; *Gypætus* at the base of the other, and leading to *Vultur* and *Otogyps*.

The *Circætinæ* include *Circætus*, *Geranospizias*, *Helotarsus*, and *Spilornis*. Closely allied, and intermediate between it and the next sub-family—the *Circinæ*—comes the highly specialized *Polyborinæ*. It seems to me that this sub-family might perhaps as well be included in the *Circinæ*, with which, as Dr. Suschkin shows, it has many characters in common, and in this I can confirm him.

The *Circinæ* embrace *Circus*, *Geranospizias*, *Urotriorchis*, and *Strigiceps*.

The *Urubitinginæ* I have added on my own responsibility. Dr. Suschkin speaks of them as isolated forms related to the *Circætinæ*.

The *Buteoninæ* include *Buteo*, *Archibuteo*, *Tachytriorchis*, *Geranoætus*, *Rupornis*, *Leucopternis*, and apparently *Busarellus*, *Butastur*, *Antenor*, and *Asturimula*.

In the *Accipitrinæ* Dr. Suschkin includes *Accipiter*, *Astur*, *Melierax*, *Urospizias*, *Lophospizias*, *Scelopspizias*, and *Nisoides*.

Though we cannot regard this scheme as final, yet, it must be admitted, it is one which is in many respects an advance upon previous arrangements of this most difficult of groups. In its construction an attempt has been made to follow the lines of phylogenetic descent, the only satisfactory basis of classification, yet a peculiarly difficult one in all questions of avian descent, owing to the lack of annectant fossil forms.

Finally, it is to be noted, the *Falconiformes* are by no means so uniformly desmognathous as is generally supposed. Mr. Beddard has given several exceptional cases, and in the present paper the list is further extended. But it seems clear that both desmognathous and schizognathous palates are to be regarded as modifications of a Gruine-schizognathous type. The *Cathartæ* have transformed the peculiarities of this type into the unique desmognathism already described. The forms which still retain a schizognathous palate have slightly modified the peculiarities of the original form by loss of the septo-maxillary spurs. Further specialization has resulted in the reduction of the maxillo-palatines to the vanishing point, e. g. *Elanus*. But the majority of the *Falconiformes* have greatly increased the size of the maxillo-palatines till they meet in the middle line (*a*) embracing the nasal septum between them (indirect desmognathism), or (*b*) meet beneath the septum fusing with one another (complete desmo-

gnathism). The various transitional schizognathous types which occur with considerable frequency, and sporadically, indicate the steps by which these two forms of desmognathism have been acquired.

The presence of the hemipterygoid element in all save the Falcons is a point of considerable interest, serving not only as an additional index of the high degree of specialization which the family has undergone, but also to show how a character common to the members of several widely different orders has been independently acquired by the modification of a common plan of structure.

As I have recently pointed out, the Neognathine (Carinate) palate has been derived directly from the dromæognathous found only in the Palæognathæ. The movement of the palatines towards the mid-ventral line, whereby they come to underlie the distal ends of the pterygoids, has caused the latter to segment and the formation of a pseudo palato-ptyergoid joint. The segmentation of the pterygoids and the fusion of the distal segments thereof with the palatines relieved them from their function of supporting the vomer and threw the work upon the palatines. As a consequence atrophy of the hemipterygoid ensued; indeed, in all the members of some sub-orders, *e. g.* Anseres, Galli, and in the Falcones, it has been entirely suppressed. When present, save in a few exceptional cases, it has lost all actual connection with the vomer, which is borne entirely by the palatines.

The evolution of the Neognathine palate has effected the following changes:—

1. A shortening of the pterygoids, by the segmentation of their distal ends and the fusion thereof with the palatines.
2. A lengthening of the palatines, by their forward growth beneath the maxillo-palatine processes, with which they originally united, to effect a union with the premaxilla; and a change in their position by the movement inwards to meet in the mid-ventral line.
3. A reduction in the size of the vomer, resulting frequently in its complete suppression.

But besides changes of position in their relative lengths, the pterygoids have also undergone a change of function, since these bones now serve as mere backward extensions of the palatines, their original function, the support of the vomer, being transferred as aforesaid to the palatines.

Similarly, the palatines have assumed new functions, in addition to the support of the vomer. They occupy, functionally, with the now subordinated pterygoids, the place of the conspicuous submedian vomero-ptyergoid bar of the Palæognathine skull, wherein, it will be remembered, they formed but little more than an appendix to the pterygoid.

## X. KEY TO THE OSTEOLOGY OF THE FALCONIFORMES.

## A. SKULL.

Upper jaw more or less markedly hooked; nostrils holorhinal, and when pervious, associated with functional basipterygoid processes; temporal fosse, when present, confined to the lateral aspect of the skull; supra-orbital grooves absent; vomer blade-shaped; palate desmo- or schizognathous; an ossiculum lachrymo-palatinum is never present.

- A. Palate indirectly desmognathous, being bridged by union of the septo-maxillary spurs with a horizontal plate developed by the ossified nasal septum; olfactory chamber of great size; lachrymal fused with frontal; nares pervious; basipterygoid processes functional; vomer wanting ..... CATHARTÆ.
- B. Palate indirectly desmognathous; basipterygoid processes functional; maxillo-palatines with an enormous antrum of Highmore; lachrymal with a very large supra-orbital process closely applied throughout its whole length to the frontal, and with its descending process reaching to the quadrato-jugal bar. .... SERPENTARIÆ.
- C. Palate directly or indirectly desmognathous or schizognathous; nares impervious; basipterygoid processes vestigial or wanting. .... ACCIPITRES.

*Key to the Families of the Accipitres.*

- A. Vomer terminating anteriorly in a more or less conspicuous olive-shaped swelling, closely applied to the maxillo-palatine processes. Palate directly desmognathous; antorbital plate (prefrontal) largely developed and with outer border closely applied to or fusing with the lachrymal; lachrymal without superciliary plate; squamosal prominence strongly developed; nostrils with a very small circular or slit-like aperture; ventral aspect of premaxilla with a median bony ridge; mandible with a ramal vacuity ..... FALCONIDÆ.
- B. Vomer never expanded anteriorly, and never applied to the under surface of the maxillo-palatines; palate indirectly desmognathous, or schizognathous; antorbital plate (prefrontal) generally tongue-shaped, often much reduced, or articulating, or even fusing by its free end with the distal extremity of the lachrymal; nostrils slit-like or pear-shaped, and fully exposing the nasal septum; lachrymal generally provided with a superciliary plate; squamosal prominence not greatly developed ..... BUTEONIDÆ.

*Key to the Sub-families of the Falconidæ.*

- A. Supra-orbital process of lachrymal extending backwards beyond middle of orbit; temporal fossa heart-shaped. .... Falconinæ.
- B. Supra-orbital process of lachrymal not extending as far as the middle of the orbit; temporal fossa elliptical ..... Polyborinæ.

## B. STERNUM AND PECTORAL GIRDLE.

Corpus sterni very large, relatively to the size of the girdle, oblong, and with relatively small anterior lateral processes which bear facets for the articulation of the anterior sternal ribs; posterior border entire, notched or fenestrated, but the posterior lateral processes are never very large; articular surfaces for sternal ribs extend up to or beyond the middle of the sternal plate; coracoid grooves wide, but shallow, and bordered above by a well-marked "lip"; coracoids slightly overlapping or only touching one another, and with a well-marked *processus lateralis basalis*; acrocoracoid very large; furcula U-shaped and very broad, with a feebly developed hypocleidum.

- A. Corpus sterni with metasternum produced into a point, bounded by a pair of notches; furcula articulating with the antero-inferior angle of keel; acrocoracoid not affording an articular surface for furcula ..... SERPENTARIÆ.
- B. Corpus sterni with posterior border with two pairs of notches, the outer pair sometimes becoming closed to form fenestræ; keel very deep, extending backwards to extreme end of sternum; coracoid grooves divided from one another in the middle by a strong ridge; acrocoracoid without articular facets for furcula. .... CATHARTÆ.

- C. Corpus sterni with posterior border notched, fenestrated, or entire; coracoid grooves overlapping; acrocoracoid with well-marked facet for articulation of furcula..... ACCIPITRES.

### Key to Families of the Accipitres.

- A. Spina externa and interna well developed; procoracoid large, articulating with clavicle..... FALCONIDÆ.  
 B. Spina externa only present; procoracoid articulating with scapula only and widely separated from clavicle ..... ACCIPITRIDÆ.

### C. PELVIC GIRDLE.

Preacetabular ilium very long and with the external lateral border more or less markedly concave; pectineal process wanting; supra-trochanteric processes generally prominent and raised high above anti-trochanter; pubis, when present, generally closely approximated to the ventral border of the ischium.

- A. Postacetabular ilium shorter than ischium, but without a notch indicating the two elements posteriorly ..... SERPENTARIÆ.  
 B. Postacetabular ilium shorter than ischium, and the limitations of the two elements indicated posteriorly by a deep notch, the ischium being continued backwards as a sharp spine along the pubis; pubis projecting far beyond ischium. CATHARTÆ.  
 C. Postacetabular ilium shorter than ischium, and much deflected; ischium never produced backwards into a spine; pubis often vestigial..... ACCIPITRES.

### xi. EXPLANATION OF THE PLATES.

#### PLATE XXXI.

##### Ventral Aspect of the Skull.

- Fig. 1. Skull of *Catharistes urubu*, showing the type of desmognathism peculiar to the Cathartæ, wherein the palate is bridged by the union of the horizontal plate of the nasal septum with a pair of septo-maxillary spurs. Note also the presence of basipterygoid processes.  
 Fig. 2. Skull of *Elanus ceruleus*. The palate is schizognathous. Herein the maxillo-palatines have increased in size, whilst the septo-maxillary spurs have completely disappeared. The nasal septum is more complete than in *Catharistes* and may be seen lying in the middle line of the anterior palatal vacuity. Above the inflated region of the maxillo-palatines it sends downwards a feeble pair of spurs which nearly touch the maxillo-palatines. The basipterygoid processes are represented only by a pair of minute prickles.  
 Fig. 3. Skull of *Falco minor*. The palate is completely desmognathous. Note the peculiar form of the vomer, and its relation to the maxillo-palatines. The antrum of the maxillo-palatines is reduced to the merest vestige.  
 Fig. 4. Skull of *Circæetus gallicus*. The palate is schizognathous, and an exaggeration of that seen in *Elanus*. Fusion of the approximated maxillo-palatines and a downgrowth of and addition to the substance of the nasal septum would give the palate of *Falco*. Note the palatal aperture of the antrum.  
 Fig. 5. Skull of *Pseudogyps bengalensis*. The palate is indirectly desmognathous. The palate is bridged by the fusion of the greatly swollen nasal septum with the widely separated maxillo-palatines.  
 Fig. 6. Skull of *Gypætus barbatus*. The palate is indirectly desmognathous, and of the same type as in *Gyps*, but from its less specialized condition shows how the palate of *Gyps* has been derived. The vomer is present, the maxillo-palatines are of great length and widely separated, whilst the nasal septum can be traced throughout its entire length.  
 Fig. 7. Skull of *Serpentarius serpentarius*. The palate is schizognathous, since the maxillo-palatines, though closely approximated, do not fuse. Fusion would produce the completely desmognathous type of *Falco*. The antrum of the maxillo-palatines is of great size, and the maxillo-palatine processes are large.

#### Explanation of letters.

- A.p.v.* = anterior palatal vacuity.    *p.a.a.* = palatal aperture of antrum.  
*bp.p.* = basipterygoid process.    *pt.* = pterygoid.  
*mx.p.* = maxillo-palatine process.    *s.* = spur of nasal septum.  
*n.s.* = nasal septum.    *vo.* = vomer.  
*p.a.* = palatine.



## PLATE XXXII.

- Fig. 1. Dorsal aspect of skull of *Catharistes urubu*, showing the absence of orbital processes to the lachrymals and the imperfect nasal hinge.
- Fig. 2. Dorsal aspect of skull of *Serpentarius serpentarius*, showing the large orbital processes of the lachrymals and their relation to the frontals.
- Fig. 3. Dorsal aspect of the skull of *Buteo jakal*, showing the large, outstanding orbital processes and the superciliary plate.
- Fig. 4. Dorsal aspect of the skull of *Falco minor*, showing the large outstanding orbital processes of the lachrymal and the absence of a superciliary plate.
- Fig. 5. Dorsal aspect of the skull of *Pandion haliaëtus*, showing the absence of orbital processes to the lachrymal. Compare this fig. with the skull of *Catharistes*, fig. 1, and note that in *Pandion* the lachrymal appears on the surface of the skull.
- Fig. 6. Dorsal aspect of the skull of *Microhierax*, to show the nasal hinge.
- Fig. 7. Lateral aspect of the skull of *Microhierax fringillarius*, to show the nasal hinge.
- Fig. 8. Lateral aspect of the skull of *Falco minor*, to show the relation of the lachrymal to the antorbital plate (prefrontal) and the shape of the nostril.
- Fig. 9. Lateral aspect of the lachrymo-nasal region of *Pandion haliaëtus*, to show the fusion of the lachrymal with the antorbital plate.
- Fig. 10. Lateral aspect of the lachrymo-nasal region of *Serpentarius serpentarius*, to show the relation of the lachrymal to the antorbital plate, and the great size of the antrum of Highmore.

*a.p.* = antorbital plate.  
*l.* = lachrymal.  
*n.h.* = nasal hinge.  
*s.* = superciliary plate.  
*or.l.* = orbital process of lachrymal.

## PLATE XXXIII.

- Fig. 1. Lateral view of the upper jaw of *Hierofalco gyrfalco*, showing the gradual suppression of the vertical bullate portion of the maxillo-palatine by the increasing development of the anterior olfactory chamber (vestibulum externus).
- Fig. 2. Lateral view of the upper jaw of *Harpa australis*, showing the more primitive condition of the vertical bullate portion of the maxillo-palatines in the *Falconinæ*.
- Fig. 3. Lateral view of the upper jaw of *Milvago chimachima*, showing the more primitive condition of the bullate portion of the maxillo-palatines in the *Polyborinæ*.
- Fig. 4. Lateral view of the upper jaw of *Herpetotheres cachimans*, showing the maximum development of the bullate portion of the maxillo-palatines reached by the *Falconinæ*.
- Fig. 5. Lateral view of the upper jaw of *Ibycter ater*, showing the maximum development of the bullate portion of the maxillo-palatines reached by the *Falconinæ*.
- Fig. 6. Dorsal aspect of the palatal bones of a young *Pernis apivorus*; to show the hemipterygoids.
- Fig. 7. Lateral view of the palatal bones of a young *Pernis apivorus*, to show the relation of the hemipterygoid to the vomer.
- Fig. 8. Lateral view of the lachrymo-nasal region of the skull of *Psophia*, after removal of the lachrymal and part of nasal, to show the septo-maxillary spurs and their relation to the maxillo-palatines and nasal septum.

*h.pt.* = hemipterygoid.  
*mx.p.* = maxillo-palatine.  
*n.s.* = nasal septum.  
*v.e.* = vestibulum externus.  
*vo.* = vomer.

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# THE ZOOLOGICAL SOCIETY OF LONDON.

---

THIS Society was founded in 1826 by Sir STAMFORD RAFFLES, Mr. J. SABINE, Mr. N. A. VIGORS, and other eminent Naturalists, for the advancement of Zoology and Animal Physiology, and for the introduction of new and curious subjects of the Animal Kingdom, and was incorporated by Royal Charter in 1829.

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Persons who wish to become Fellows of the Society are requested to communicate with the undersigned.

PHILIP LUTLEY SCLATER, M.A., D.Sc., F.R.S.,  
*Secretary.*

Hanover Square, London, W.,  
August, 1902.

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OF THE  
**ZOOLOGICAL SOCIETY OF LONDON**  
FOR  
SCIENTIFIC BUSINESS.  
(AT 3 HANOVER SQUARE, W.)  
**Session 1902-1903.**

1902.

TUESDAY, NOVEMBER 4 and 18      |      TUESDAY, DECEMBER 2

1903.

<p>TUESDAY, JANUARY 20</p> <p style="padding-left: 2em;">" FEBRUARY 3 and 17</p> <p style="padding-left: 2em;">" MARCH .. 3 .. 17</p>		<p>TUESDAY, APRIL .. 21</p> <p style="padding-left: 2em;">" MAY .... 12 and 26</p> <p style="padding-left: 2em;">" JUNE .... 16</p>
---	--	---

*The Chair will be taken at half-past Eight o'clock in the Evening  
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## OF THE

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[August, 1902.]



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\* Part V. of Vol. XVI., containing Mr. Mudge's paper on the Myology of the Tongue of Parrots, is not yet ready and will be issued subsequently.

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August, 1902.

PROCEEDINGS  
OF THE  
GENERAL MEETINGS, FOR SCIENTIFIC BUSINESS  
OF THE  
ZOOLOGICAL SOCIETY  
OF LONDON.  
1902, vol. I.

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PART I.  
CONTAINING PAPERS READ IN  
JANUARY AND FEBRUARY.

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JUNE 1st, 1902.

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LONDON:  
MESSRS. LONGMANS, GREEN, AND CO.,

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PART II.  
CONTAINING PAPERS READ IN  
MARCH AND APRIL.

---

AUGUST 1st, 1902.

PRINTED FOR THE SOCIETY,  
SOLD AT THEIR HOUSE IN HANOVER SQUARE.

LONDON:  
MESSRS. LONGMANS, GREEN, AND CO.,  
PATERNOSTER-ROW 72084

[Price Twelve Shillings.]

SEP 23 1902



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